OPERATION AND MAINTENANCE INSTRUCTION MANUAL FOR IRD MECHANALYSIS VIBRATION-SPIKE ENERGY CHECKER MODELS 810, 810M AND 811

OPERATION AND MAINTENANCE INSTRUCTION MANUAL FOR IRD MECHANALYSIS VIBRATION-SPIKE ENERGY CHECKER MODELS 810, 810M AND 811

IRD Mechanalysis, Inc.
Subsidiary of H. H. Robertson Company
6150 Huntley Road
Columbus, Ohio 43229
614-885-5376
Telex 24-5318

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I INTRODUCTION

1.1 PURPOSE AND SCOPE OF MANUAL

This instruction manual describes IRD Mechanalysis Vibration-Spike Energy Detector, Models 810, 810M, and 811, and includes instructions on preparation, setup, operation, and service of this instrument. The manual is divided into five chapters as follows:

Chapter I, INTRODUCTION, consists of a brief description of the manual, and the purpose and capability of Models 810, 810M, and 811 instruments and accessories.

Chapter II, DESCRIPTION, describes the controls, indicator meter, and accessories of the instrument. This includes the standard and optional accessories. A photograph of each component, along with a description is included to facilitate use of the manual and instrument. Specifications are included in this chapter for the instrument and accessories.

Chapter III, PREPARATION FOR OPERATION, contains instructions on mounting the vibration pickup, hand-holding the pickup, connection of the input cables, and step-by-step procedures on checking the instrument operation and condition of the internal batteries.

Chapter IV, OPERATION, contains setup instructions, operational guides on vibration measurement, determining severity and dominant frequency of the vibration, classifying the vibration, and in-place balancing procedures.

Chapter V, SERVICE, contains a basic description of the instrument circuit operations, calibration instructions, a trouble-shooting guide, plus an illustrated parts listing of all replaceable parts, and a recommended spare parts list. In addition, instructions are included as to where and how

service is obtained for the instrument or accessories.

1.2 PURPOSE AND CAPABILITY OF INSTRUMENT

The Vibration-Spike Energy Detector is a compact portable instrument, which can be hand-held for vibration measurement or balancing of rotating machines. This instrument measures machinery vibration in displacement, velocity, and acceleration. In addition, it also measures the Spike Energy associated with bearing and gear defects over a very wide range of frequency.

The operating conditions of a rotating machine that eventually cause machine breakdown, can be detected from the measurements provided by the Vibration-Spike Energy Detector. Periodic measurement of the machine vibrations, combined with a time log of the vibration levels will provide the basic information required for an effective Preventive Maintenance Program for a rotating machine. If significant increases develop in the machine vibration levels, then trouble is indicated in the machine. These troubles can then be pinpointed to specific machine parts, and scheduling can be arranged for machine repair.

NOTE: If the rotating machine vibrations are beyond the capability of the Model 810, 810M, or 811 instrument, a more sophisticated instrument can be obtained from IRD Mechanalysis for performing a complete vibration spectrum analysis of the machine vibrations; or Consulting Service can be obtained from IRD for these services.

IRD Mechanalysis offers complete training on vibration measurement, analysis, and balancing to its customers, in principal cities throughout the world. For details in this training, contact your nearest IRD representative, or write to IRD Mechanalysis, 6150 Huntley Road, Columbus, Ohio 43229, U.S.A.

II DESCRIPTION

2.1 GENERAL

The IRD Mechanalysis, Model 810, 810M, or 811 Vibration-Bearing-Gear Checker and standard accessories consist of the instrument, a Model 970 Accelerometer (pickup), an input-signal cable, a straight probe for connection to the accelerometer, an instruction manual, and a carrying/storage case for the instrument and standard accessories.

This section contains descriptions of the instrument controls and amplitude meter, and connector receptacles of instrument and accelerometer. In addition, specifications are also included for the Model 810, 810M, and 811 instruments, Model 970 Accelerometer, and Model 544 Vibration pickup.

The front view of the Model 810 with callouts is shown in Figure 2-1 (the Model 810M and 811 differ slightly from Model 810 as explained herein).

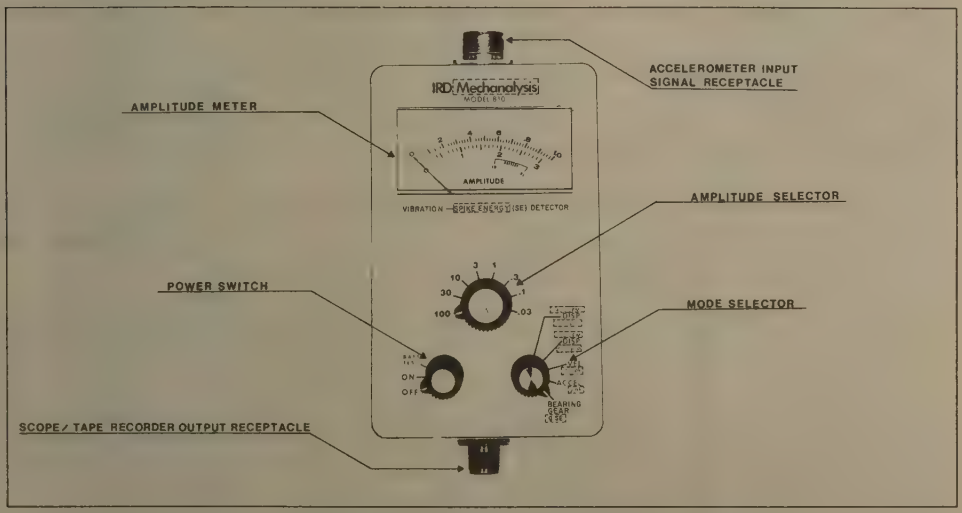
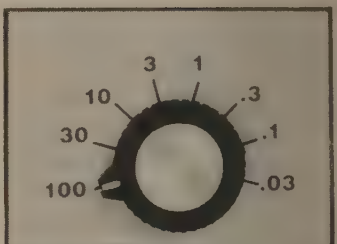


Figure 2-1 Model 810 Front Panel Details

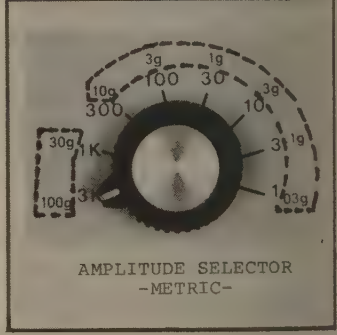
2.2 DESCRIPTION OF CONTROLS AND INDICATOR

AMPLITUDE SELECTOR

The AMPLITUDE SELECTOR is used to select the full-scale range of amplitude for indication on the AMPLITUDE METER, and range from 0.03 to 100 mils, pk-pk, in/sec., pk, or g's, pk, in the English units; and from 1 to 3000 micrometers, pk-pk, or mm/sec., pk, and 0.03 to 100 g's, pk, in Metric units. In addition, the Model 811 also has ISO ranges from 1 to 3000 mm/sec., rms. Eight selectable amplitude ranges are provided as listed in the following table:



AMPLITUDE SELECTOR
-ENGLISH-

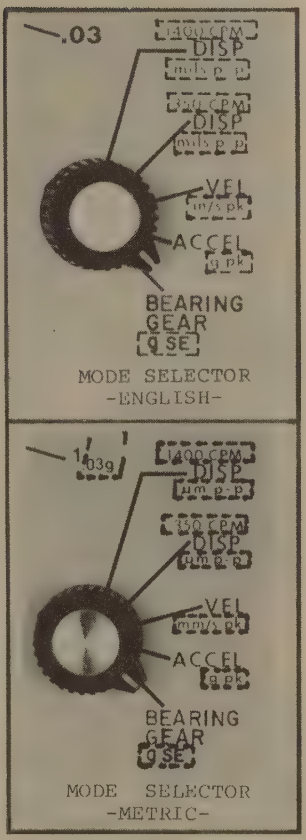


AMPLITUDE SELECTOR
-METRIC-

AMPLITUDE RANGE VALUES			
ENGLISH UNITS (MODEL 810)	METRIC UNITS PROVIDED IN (MODELS 810M AND 811)		ISO UNITS PROVIDED IN (MODEL 811)
MILS, pk-pk IN/SEC, pk or g's, pk	MICROMETERS, pk-pk/mm/sec; pk.	g's, peak	MM/SEC, RMS
0 to 0.03	0 to 1.0	0 to 0.03	0 to 1.0
0 to 0.1	0 to 3.0	0 to 0.1	0 to 3.0
0 to 0.3	0 to 10.0	0 to 0.3	0 to 10.0
0 to 1.0	0 to 30.0	0 to 1.0	0 to 30.0
0 to 3.0	0 to 100	0 to 3.0	0 to 100
0 to 10.0	0 to 300	0 to 10.0	0 to 300
0 to 30.0	0 to 1000	0 to 30.0	0 to 1000
0 to 100	0 to 3000	0 to 100	0 to 3000

MODE SELECTOR

The MODE SELECTOR is used to select the desired measurement units which are provided as follows:



A. DISP 350 CPM: provides measurement in DISPLACEMENT (mils or micrometers, pk-pk: from 350 to 60,000 CPM or 5.8 to 1000 Hz with 970 Accelerometer; 600 to 60,000 CPM or 10 to 1000 Hz with 544 Velocity Pickup).

B. DISP 1400 CPM: provides measurement in DISPLACEMENT (mils or micrometers, pk-pk: from 1400 to 60,000 CPM or 23.3 to 1000 Hz with 970 Accelerometer or 544 Velocity Pickup). This mode eliminates low-frequency energy in the output.

C. VEL: provides measurement in VELOCITY (inches/sec or mm/sec, pk: from 350 to 600,000 CPM or 5.8 to 10,000 Hz with 970 Accelerometer; 600 to 60,000 CPM or 10 to 1000 Hz with 544 Velocity Pickup).

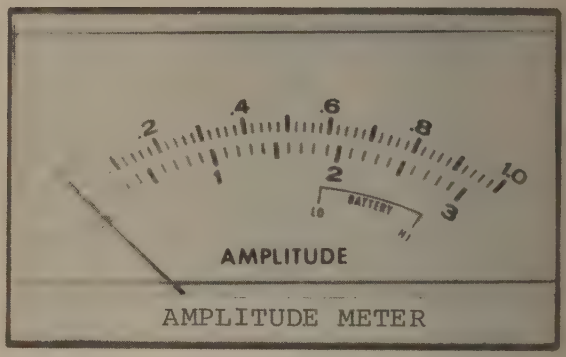
D. ACCEL: provides measurement in ACCELERATION (g's, peak, from 240 to 600,000 CPM or 4 to 10,000 Hz) and is used only with the 970 Accelerometer.

E. BEARING GEAR g's SE: provides measurement in relative ACCELERATION (g's SE of bearing, gear, or other machine part, spike energy, over inclusive range of from 300,000 to 2,400,000 CPM, or 5000 to 40,000 Hz. This range is used only with the 970 Accelerometer.

F. ISO: provides INTERNATIONAL STANDARDS ORGANIZATION measurement in DISPLACEMENT (mm/sec, RMS, from 600

to 600,000 CPM, or 10 to 1000 Hz, with the 970 Accelerometer. This mode is available only in the Model 811 Instrument.

AMPLITUDE METER

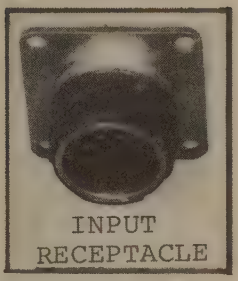


AMPLITUDE METER

The AMPLITUDE METER indicates the vibration amplitude, and the condition of the internal batteries (in BATT TEST). Two scales are provided: the upper scale for indication of the 0 to 0.1, 1.0, 10, 100, and 1000 unit ranges; the lower scale for indication of the 0 to 0.03, 0.3, 3.0, 30, 300, and 3000 unit ranges; in addition, the condition of the internal batteries is shown in the LO--BATT--HI area of the lower scale in the BATT TEST mode. The values of each range, the meter scale to be used, and the measuring units used are shown in the following table:

ENGLISH UNITS		METRIC UNITS			
MILS AND IN/SECOND RANGES	METER SCALE USED	METER AND MM/SEC RANGES	METER SCALE USED	ACCELERATION (g's) RANGES	METER SCALE USED
0 to 0.03	Lower	0 to 1.0	Upper	0 to 0.03	Lower
0 to 0.1	Upper	0 to 3.0	Lower	0 to 0.1	Upper
0 to 0.3	Lower	0 to 10	Upper	0 to 0.3	Lower
0 to 1.0	Upper	0 to 30	Lower	0 to 1.0	Upper
0 to 3.0	Lower	0 to 100	Upper	0 to 3.0	Lower
0 to 10	Upper	0 to 300	Lower	0 to 10	Upper
0 to 30	Lower	0 to 1000	Upper	0 to 30	Lower
0 to 100	Upper	0 to 3000	Lower	0 to 100	Upper

PICKUP SIGNAL INPUT RECEPTACLE

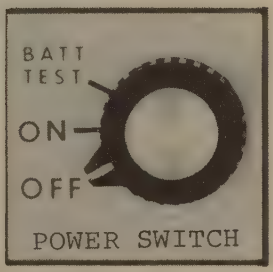


The PICKUP SIGNAL INPUT RECEPTACLE is a 9-pin twist-lock type of connector. It is located at the top end of the instrument, and is used for connection of the input cable from the 970 Accelerometer (or 544 Velocity Pickup).

OSCILLOSCOPE/TAPE RECORDER/ANALYZER OUTPUT RECEPTACLE

The OSCILLOSCOPE/TAPE RECORDER/ANALYZER OUTPUT RECEPTACLE receives the signal cable from an optional oscilloscope, tape recorder, or other type of instrument. A 2-pin threaded connector, No. 5857 (MS No. 3106E10S4S) is required for connection to the receptacle. Full-scale output, 746 mv, rms, for English units, and 301 mv, rms, for Metric units; Impedance 100K ohms.

POWER SWITCH



The POWER SWITCH is used to connect the internal battery supply to the instrument circuits, and to check the batteries for a proper output voltage. If set to OFF, power is disconnected. If set to ON, power is connected to the instrument circuits. If set to BATT-TEST, the AMPLITUDE meter indicates within the LO-BATT-HI area of the meter scale if the batteries have sufficient output voltage. If the meter indicates at or below the LO point of the scale, then the batteries must be replaced before the instrument can be used.

See instruction on replacement of the internal batteries in Chapter Five.

2.3 DESCRIPTION OF ACCESSORIES

2.4.1 STANDARD ACCESSORIES

The standard accessories of the Vibration-Spike Energy Detector are pictured in Figure 2-2, listed below, and referenced to succeeding paragraphs.

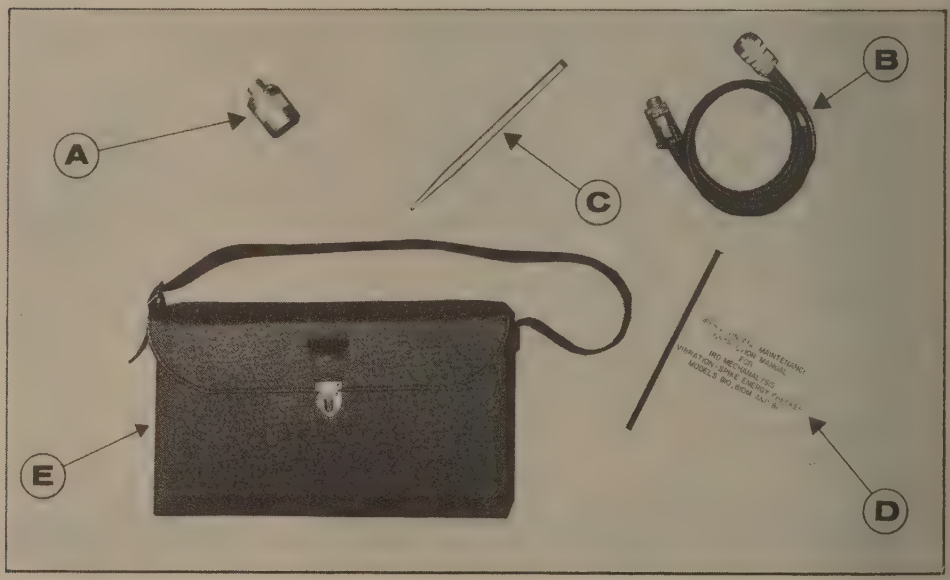


Figure 2-2 Standard Accessories

A. Accelerometer, Model 970, Part No. 19697.

B. Pickup Cable, 4-foot, Part No. 20430.

C. Extension Probe, 9-inch, Part No. 1103, for connection to accelerometer.

D. Instruction Manual, Part No. 21072.

E. Storage Case, Part No. 21101, for instrument and standard accessories.

ACCELEROMETER (Fig. 2-2, Ref. A)

The Model 970 Accelerometer, Part No. 19697, can be used in any position without loss of accuracy or sensitivity. It is sensitive to vibrations along the long axis, and can be fastened to the rotating machine with a 1/4-28 x 1/4-inch stud. It can also be used with a magnetic pickup holder, or can be hand-held with or without an extension probe. The accelerometer specifications are listed in Section 2.5.

PICKUP CABLE (Fig. 2-2, Ref. B)

The Pickup Cable, Part No. 20430, is four feet in length, and connects the Accelerometer vibration signal to the 9-pin twist-lock receptacle at the top end of the instrument. In addition, this cable also carries the dc supply voltage to the internal preamplifier of the Accelerometer. The cable connector at the external end of the cable connects to the 4-pin threaded receptacle at the top end of the Accelerometer.

EXTENSION PROBE (Fig. 2-2, Ref. C)

The Extension Probe, Part No. 1103, is 9-inches in length, and connects to the threaded hole at the flat end of the Accelerometer. It is used to reach inaccessible places on the rotating machine, when the Accelerometer is hand held. The probe should not be used to measure vibration signals above 16,000 CPM.

INSTRUCTION MANUAL (Fig. 2-2, Ref. D)

The Instruction Manual, Part No. 21072, provides instructions on setup, operation, and servicing the Model 810, 810M, or 811 Vibration-Spike Energy Detector. Additional copies of the manual are available from IRD Mechanalysis.

STORAGE CASE (Fig. 2-2, Ref. E)

The Storage Case, Part No. 21101, provides space for carrying or storage of the instrument along with the standard accessories.

2.4.2 OPTIONAL ACCESSORIES

The optional accessories available for use with a Model 810, 810M, or 811 instrument are pictured in Figure 2-3, and referenced to succeeding paragraphs in this section.

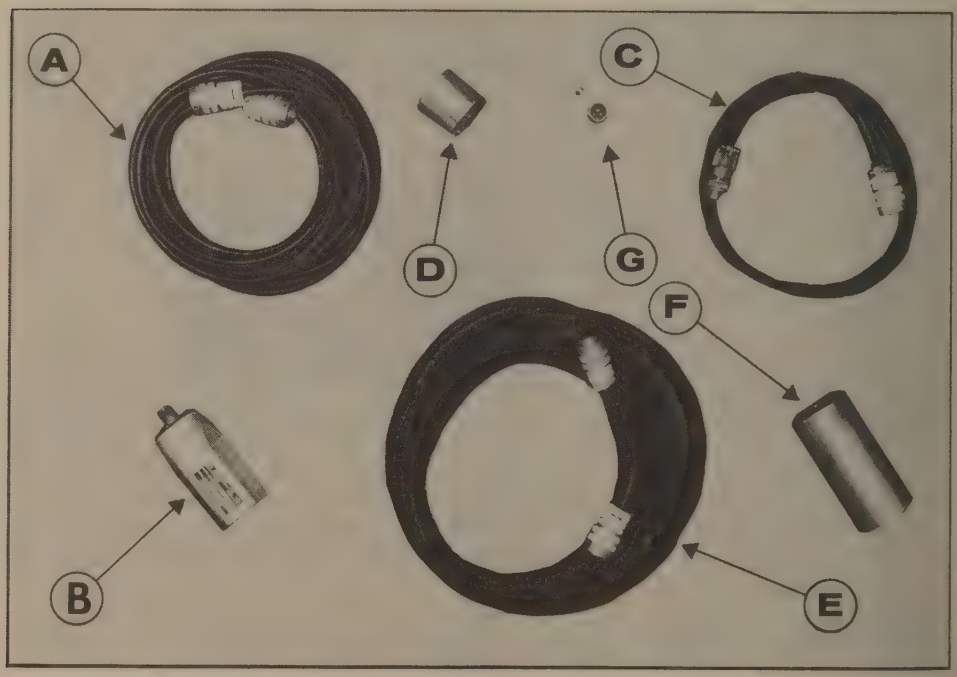


Figure 2-3 Optional Accessories

EXTENSION CABLE FOR 970 (Fig. 2-3, Ref. A)

The Extension Cable, Part No. 20431, is 25-feet in length, and can be connected to the external

end of the standard cable to increase the overall pickup cable length to 29 feet.

VELOCITY PICKUP, MODEL 544 (Fig. 2-3, Ref. B)

The Velocity Pickup, Model 544, Part No. 4526, can be used in place of the Model 970. The 544 can be mounted in any position without affecting the accuracy or sensitivity (within the specification limits listed for this pickup, see Table 2-3). This pickup is sensitive only to vibraiton along the long axis, and can be stud-mounted to the rotating machine, used with a magnetic holder, or hand-held with or without an extension probe.

PICKUP CABLE, MODEL 544 (Fig. 2-3, Ref. C)

The 544 Pickup Cable, Part No. 20432, is 4 feet in length, and connects the pickup vibration signal to the instrument. The 9-pin connector at the instrument end connects to the twist-lock receptacle at the top end of the instrument. The threaded connector at the pickup end of the cable connects to the threaded receptacle at the top end of the 544 Pickup.

MAGNETIC HOLDER (Fig. 2-3, Ref. D)

The Magnetic Holder, Part No. 4332, can be used to hold a 970 Accelerometer or 544 Pickup to the rotating machine. The magnetic holder stud mounts to the flat end of either pickup, and provides a strong magnetic force for holding the pickup to the mounting. This holder should not be used if the vibrations to be measured contain frequency components above 37,000 CPM.

EXTENSION CABLE FOR 544 (Fig. 2-3, Ref. E)

The Extension Cable, Part No. 21045, is 25 feet length, and is used to extend the standard cable length to 29 feet. This cable connects to the receptacle at the instrument end of the short cable. The twist-lock connector at the other end of the

extension cable connects to the receptacle at the top end of the instrument.

MAGNETIC SHIELD (Fig. 2-3, Ref. F)

The Magnetic Shield, Part No. 10449, can be used with the Model 544 Velocity Pickup to reduce the magnetic field effects to 0.0015 inch/second gauss (reduction of 100 to 1) at 60 Hz. The magnetic shield fits over the 544 Pickup and is held in place by a special mounting adapter included with the magnetic shield.

CALIBRATOR (Fig. 2-3, Ref. G)

The Calibrator, Part No. 21073, can be used to check the operation and calibration of the Model 810, 810M, 811 instrument. It connects to the external end of the pickup cable. The supply voltage to the Calibrator comes from the instrument batteries. Details on use of Calibrator are provided in Chapter 3.

VISE GRIP PLIERS (Not Pictured)

The Vise Grip Pliers, Part No. 1821, can be used as an item of convenience, if desired, for holding the Model 544 Velocity Pickup to the rotating machine for balancing. The threaded pickup stud mounts to the pliers, and the plier jaws are used to clamp to the rotating machine.

CAUTION: The Vise Grip Pliers must not be used for vibration measurement except when balancing a rotating machine. In addition, do not use the Vise Grip Pliers with a Model 970 Accelerometer.

2.5 SPECIFICATIONS

This section contains specifications for the Model 810, 810M, and 811 Vibration-Spike Energy Detector, the Model 970 Accelerometer, and the Model 544 Velocity Pickup. Table 2-1, which follows lists

the Specifications for the Model 810, 810M, or 811 Vibration-Spike Energy Detector:

TABLE 2-1 MODEL 810, 810M, AND 811 SPECIFICATIONS

ITEM	SPECIFICATION
FREQUENCY RANGE	With 970 Accelerometer: 350 to 600,000 CPM (5.8 to 10,000 Hz); With 544 Pickup: 600 to 60,000 CPM (10 to 1000 Hz).
FREQ. RESPONSE	
A. DISPLACEMENT	DISP 350 CPM: With 970 Accelerometer, 350 to 60,000 CPM (5.8 to 1000 Hz; With 544 Pickup, 600 to 60,000 CPM (10 to 1000 Hz). DISP 1400 CPM: With 970 Accelerometer or 544 Pickup, 1400 to 600,000 CPM (23.3 to 10,000 Hz). ISO (Model 811 only): With 970 Accelerometer only, 600 to 60,000 CPM in millimeters per second, rms, to ISO 2954 Standard.
B. VELOCITY	With 970 Accelerometer: 350 to 600,000 CPM (5.8 to 10,000 Hz; or with 544 Pickup: 600 to 60,000 CPM (10 to 1000 Hz).
C. ACCELERATION	With 970 Accelerometer only, 240 to 600,000 CPM (4 to 10,000 Hz).
D. SPIKE ENERGY ACCELERATION	With 970 Accelerometer only, inclusive range of from 300,000 to 2,400,000 CPM (5000 to 40,000 Hz) and readout in g's peak.

TABLE 2-1 CONTINUED

ITEM	SPECIFICATION
MEASURING RANGES	
A. DISPLACEMENT	English: 0 to 100 mils, in eight full-scale, overlapping ranges; 0 to 0.03, 0 to 0.1 , 0 to 0.3, 0 to 1, 0 to 3, 0 to 10, 0 to 30, and 0 to 100 mils, peak to peak. Metric: 0 to 3000 micrometers, in eight full-scale, overlapping ranges: 0 to 1, 0 to 3, 0 to 10, 0 to 30, 0 to 100, 0 to 300, 0 to 1000, and 0 to 3000 micrometers, peak to peak.
B. VELOCITY	English: 0 to 100 inches per second, in eight full-scale, overlapping ranges: 0 to 0.03, 0 to 0.1, 0 to 0.3, 0 to 1, 0 to 3, 0 to 10, 0 to 30, and 0 to 100 in/sec, peak. Metric: 0 to 3000 millimeters per second, in eight full-scale overlapping ranges: 0 to 1, 0 to 3, 0 to 10, 0 to 30, 0 to 100, 0 to 300 0 to 1000, and 0 to 3000 mm/second, peak.
C. ACCELERATION	English and Metric: 0 to 100 g's, in eight full-scale, overlapping ranges: 0 to 0.03, 0 to 0.1, 0 to 0.3, 0 to 1, 0 to 3, 0 to 10, 0 to 30, and 0 to 100 g's, peak.
D. VELOCITY,ISO	ISO (Model 811 only): 0 to 100 mm per second, in eight full-scale overlapping ranges: 0 to 1, 0 to 3, 0 to 10, 0 to 30, 0 to 100, 0 to 300, 0 to 1000, and 0 to 3000 mm per second, rms.

TABLE 2-1 CONTINUED

ITEM	SPECIFICATION
BATT TEST	Battery condition indicated on the Amplitude Meter if POWER SWITCH is in BATT TEST. Battery output voltage sufficient for operating the instrument if the meter indication is within the LO--BATTERY--HI area of the lower meter scale.
BATTERY LIFE (continuous use)	Mercury: Model 810 or 810M, approximately 120 hours with 970 Accelerometer (170 hours with 544 Pickup); Model 811, approximately 100 hours with Model 970 Accelerometer. Zinc Carbon: Model 810 or 810M, approximately 70 hours with 970 Accelerometer (120 hours with 544 Pickup); Model 811, 60 hours with Model 970 Accelerometer. Alkaline: Model 810 or 810M, approximately 100 hours with 970 Accelerometer (140 hours with 544 Pickup); Model 811, approximately 90 hours with 970 Accelerometer.
INPUT SIGNAL	One input channel, 970 Accelerometer, 544 Pickup, or optional Calibrator. Either 970 or 544 supplies a vibration signal suitable for vibration measurement or balancing. The Calibrator supplies an input voltage suitable for checking calibration and operation.
OUTPUTS	
A. METER	Analog meter (two scales) that indicates the vibration level or

TABLE 2-1 CONTINUED

ITEM	SPECIFICATION
(Outputs Cont'd.)	condition of internal batteries.
B. OSCILLOSCOPE/ TAPE RECORDER/ANALYZER	Analog vibration output voltage for connection to an external instrument. Output level, 764 mv, rms, full-scale meter deflection for Model 810 (301 mv, rms, for Model 810M or 811). Impedance 100K ohm.
TEMPERATURE	
A. OPERATING	+30 to +122°F (-1 to +50°C) with mercury batteries. 0 to +122°F (-18 to +50°C) with alkaline or zinc-carbon batteries.
B. STORAGE	-4 to +130°F (-20 to +54°C) with batteries installed; -4 to +150°F (-20 to +66°C) without batteries.
HUMIDITY	0 to 85%, relative humidity at +104°F (+40°C).
POWER REQUIREMENT	Operates from internal battery supply. Two batteries required: mercury Part No. 9291, standard; alkaline battery, Part No. 12359, or zinc-carbon, Part No. 20395, optional. Battery life values listed on Page 2-13.
DIMENSIONS	Length: 8.25 inches (21 cm). Width: 4.56 inches (11.6 cm). Height: 3.06 inches (7.8 cm).
WEIGHT	Instrument: 33 ounces (0.94 kgm). Standard Accessories: 33 ounces (0.94 kgm).

TABLE 2-1 CONTINUED

ITEM	SPECIFICATION
CONSTRUCTION	Aluminum case, two-tone painted exterior, splash/dust-proof seal, with easy access to two internal batteries.
STANDARD ACCESSORIES	Accelerometer, Model 970, Part No. 19697. Pickup Cable, 4-foot, Part No. 20430. Extension Probe, 9-inch, straight, Part No. 1103. Storage Case, for instrument and standard accessories, Part No. 21101. Instruction Manual, Part No. 21072.
OPTIONAL ACCESSORIES	Extension Cable: 25-foot for 970 Accelerometer, Part No. 20431. Velocity Pickup: Model 544, Part No. 4526. Pickup Cable for 544 Pickup: 4-foot, Part No. 20432. Extension Cable: 25-foot, for 544 Pickup, Part No. 21045. Magnetic Holder for 970 or 544 Pickup: Part No. 4332 Magnetic Shield: for 544 Pickup, Part No. 10449. Calibrator: Part No. 20173. Vise Grip Pliers: for holding 544 Pickup to the rotating machine for balancing, Part No. 1821.

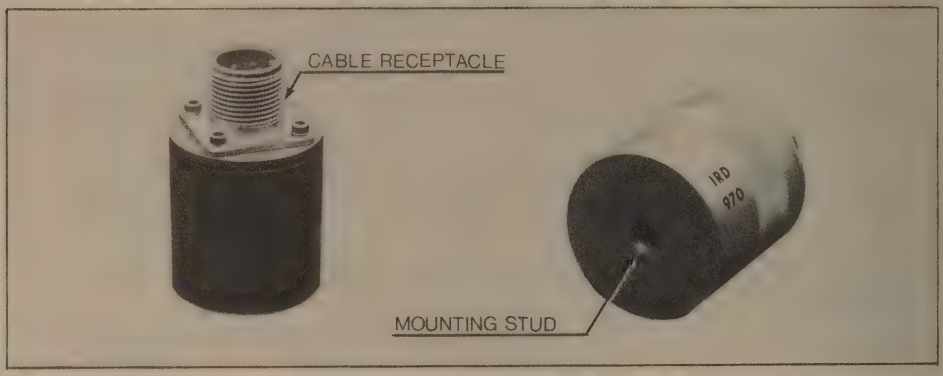


Figure 2-4 Model 970 Accelerometer

TABLE 2-2 MODEL 970 ACCELEROMETER SPECIFICATIONS

ITEM	SPECIFICATION
RESONANT FREQ.	27,000 Hz, or higher.
FREQUENCY RANGE	180 g's, peak, up to 1K Hz; 120 g's peak 5K Hz; or 70 g's peak at 10K Hz (with ±15 VDC supply and 25-foot input cable having 50 pf capacatance per foot.
NOTE: If a longer cable is used, the maximum amplitude and/or high-frequency response will be reduced. Also, if a lower voltage supply is used, the maximum amplitude will be reduced proportionally.	
SENSITIVITY	50 millivolts per g (nominal).
TEMPERATURE RANGE	From -40 to +250°F (-40 to +121°C).
ORIENTATION	Any position.
TRANSVERSE RESPONSE	5%, maximum, 3% typical.

TABLE 2-2 CONTINUED

ITEM	SPECIFICATION
MAGNETIC FIELD SENSITIVITY	Less than 0.0001 g per gauss at 60 Hz.
RESIDUAL NOISE	Less than 0.0002 g.
SUPPLY VOLTAGE	REGULATED +8 volts, at ±1.2 ma, maximum, to ±15 volts at ±1.75 ma, maximum.
HOUSING	Waterproof and dustproof, series 300 stainess steel, welded case.
CABLE RECEPTACLE	4-pin, threaded receptacle, Type 12S-10P.
GROUNDING	Case isolated from signal ground (insulated mount required if rotating machine is significantly above ground potential).
WEIGHT	7.7 ounces (200 grams).
MOUNTING	Threaded mounting hole, 1/4 - 28 x 1/4 - inch, at flat end of pickup.
AMPLITUDE	1000 g's, peak, of sinusoidal vibration, or 2000 g's, peak, with 10-millisecond half-sine, with no damage to accelerometer.

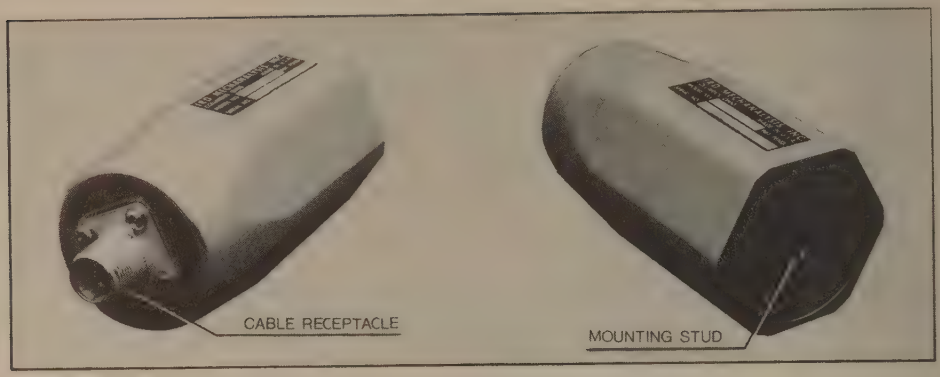


Figure 2-5 Model 544 Vibration Pickup

TABLE 2-3 MODEL 544 VIBRATION PICKUP SPECIFICATIONS

ITEM	SPECIFICATION
FREQUENCY RANGE	720 to 60,000 CPM (12 to 1000 Hz) at ±8%; -8 to +13% at 600 CPM (10 Hz).
SENSITIVITY	764 ±10% mv, rms, per in/sec, peak.
TEMPERATURE RANGE	-40 to +500°F (-40 to +260°C).
IMPEDANCE	Resistance, 2000 ohms; Inductance, 0.7 Henery.
DAMPING FACTOR	0.7 at critical frequency.
ORIENTATION	Any position, but the long axis of pickup must be aligned with rotating machine displacement.
TRANSVERSE RESPONSE	Less than 5 percent, average, from 600 to 60,000 CPM (10 to 1000 Hz).
MAGNETIC FIELD SENSITIVITY	0.15 inch/second/gauss.
HOUSING	Weatherproof and dustproof.

TABLE 2-3 CONTINUED

ITEM	SPECIFICATION
CABLE RECEPTACLE	2-pin, threaded, No. 732S-10SL-4P.
WEIGHT	21 ounces (0.06 kg).
GROUNDING	Case and signal ground, common.
MOUNTING	Threaded mounting hole, 1/4 - 28 x 1/4 inch, at flat end of pickup.
AMPLTIUDE	125 mils (3175 micrometers) maximum, up to 70 Hz, 30 g's above 70 Hz.

III PREPARATION FOR OPERATION

3.1 GENERAL

This section consists of instructions on checking the basic operation of the Vibration-Spike Energy Detector, mounting the accelerometer or velocity pickup on the rotating machine, connecting the pickup and oscilloscope/tape recorder/analyzer signal input cable, and checking the condition of the internal batteries of the instrument.

3.2 CHECKING INSTRUMENT OPERATION

The basic operation of the Vibration-Spike Energy Detector is checked as follows:

1. Set the instrument POWER SWITCH to the BATT TEST position, and check that the Amplitude Meter indicates within the LO--BATTERY--HI area on the lower meter scale. If this indication is obtained, then the internal batteries have sufficient output voltage for operating the instrument and accelerometer circuits. If the meter indicates at or below the LO point, the batteries must be replaced before the instrument can be used. Details on replacing the batteries are included in Chapter V.

2. Connect the pickup cable to the threaded receptacle on the accelerometer, and the snap lock receptacle on the top end of the instrument.

3. Set the POWER SWITCH to ON, then set the MODE SELECTOR to VELOCITY, and the AMPLITUDE SELECTOR to the 1 in/sec (or 30 mm/sec) range. Then shake the accelerometer and check that vibration is indicated by the Amplitude Meter (the meter indicator should move up-scale when the accelerometer is shaken, and should settle back to zero when the accelerometer is held still).

NOTE: A more detailed circuit check can be performed using the optional calibrator, Part No. 21073, as follows:

a. Disconnect the external end of the Pickup Cable from the accelerometer.

b. Connect the cable connector to the threaded receptacle on the calibrator.

c. On Model 810, set the AMPLITUDE SELECTOR to the 1.0 range, and set the MODE SELECTOR to the same measuring units to which the calibrator is set (VEL, g's, or DISP).

d. Check that the AMPLITUDE METER indicates 8.0 mils, 0.8 inches/second, or 0.8 g's on its upper scale.

e. On Model 810M or 811, set the AMPLITUDE SELECTOR to the 30 or 1.0 g range, and set the MODE SELECTOR to the same measuring units to which the calibrator is set (VEL, g's, or DISP).

f. Check that the AMPLITUDE METER indicates 20 micrometers or mm/sec on the lower meter scale, or 0.8 g's on the upper meter scale.

If the AMPLITUDE METER indications specified in Steps a through f are obtained in these steps, then the instrument is correctly calibrated, and the instrument circuits and Pickup Cable are both functioning correctly. Therefore, set the POWER SWITCH to OFF, disconnect the Pickup Cable from the calibrator, and proceed with Section 3.3.

3.3 VIBRATION PICKUP MOUNTING

3.1 MODEL 970 ACCELEROMETER

The Model 970 Accelerometer should be stud mounted to the rotating machine, if possible, especially

when Spike Energy is to be measured. When required, limited measurements of the vibration can be obtained when the accelerometer is held to the rotating machine magnetically, or hand held with or without the extension probe. The accelerometer should not be used in environmental temperatures greater than +250°F (+121°C).

The accelerometer should be stud mounted to a flat surface on the rotating machine housing at the bearing to be checked, using the 1/4 - 28 x 1/4 inch threaded hole at the flat end of the pickup (see Figure 2-2). The long axis of the accelerometer must be positioned in the direction of the vibration to be measured. The mounting stud must not extend into the accelerometer shell by more than 1/4-inch, maximum, otherwise the accelerometer could be damaged.

The accelerometer mounting surface must be reasonably flat, smooth, and clean (free of hardened grease, dirt, scale, paint, or other matter). Coating the flat end of the accelerometer with clean silicone grease will help insure proper bonding between the pickup and mounting surface. The accelerometer should be threaded onto the mounting stud, and hand tightened to the machine. DO NOT WRENCH THE MODEL 970 ACCELEROMETER TO THE MOUNTING SURFACE.

If desired, the optional magnetic pickup holder, Part No. 4332, can be used to hold the accelerometer to the rotating machine. The magnetic pickup holder can be fastened to the pickup using the 1/4 - 28 x 1/4 inch threaded hole and stud. If the magnetic pickup holder is used, then the maximum vibration frequency to be measured should not exceed 37,000 CPM.

The accelerometer can be hand held to the rotating machine, if required, for measurement of vibration displacement, velocity, or acceleration up to 60,000 CPM. However, no measurement of Spike Energy should be attempted when the pickup is

held by hand. To hand hold the accelerometer, the flat end should be held firmly against the machine housing so that the long axis of the pickup is positioned in the same direction as the vibration to be measured. Sufficient holding force must be provided to prevent chattering between the pickup and machine contacting surfaces. A tingling sensation in the holders fingers is an indication that more holding force is needed.

If desired, the extension probe can be connected to the flat end of the accelerometer, and the accelerometer then hand held with the tip of the extension probe contacting the various measuring points on the rotating machine. If the extension probe is used with the accelerometer, the maximum vibration frequency to be measured is 16,000 CPM. Sufficient holding force should be applied to prevent the probe tip from chattering against the machine, or the holders fingers from tingling. The extension probe enables the operator to obtain vibration measurements from parts of the rotating machine that are not readily accessible.

.3.2 MODEL 544 VELOCITY PICKUP

The optional Model 544 Velocity Pickup should be mounted to the rotating machine in the same manner described for the accelerometer. However, the velocity pickup can be used in temperatures up to +500°F (+260°C). When possible, this pickup should be stud mounted to the rotating machine.

The 544 Velocity Pickup should be mounted to a flat section of the rotating machine near the bearing to be checked, using the 1/4 - 28 x 1/4 inch threaded hole at the flat end of the pickup. The mounting surface should be reasonably smooth, flat, and clean. It should be approximately 2-1/2 inches in diameter, and should have a threaded hole (1/4 - 28 x 1/4 inch) for a mounting stud. The mounting stud must not extend into the pickup shell by more than 1/4 inch, maximum; otherwise, the pickup could be damaged. The pickup should

be hand tightened to the mount. DO NOT WRENCH THE PICKUP.

If desired, the velocity pickup can be hand-held to the rotating machine with or without the extension probe, or it can be held with the optional magnetic pickup holder. If the pickup is hand-hend to the machine, sufficient holding force should be applied to prevent the pickup or probe tip from chattering against the machine, and so that the holder's fingers do not tingle. If the pickup is hand-held without the extension probe installed, then the maximum vibration frequency to be measured is 60,000 CPM. If the pickup is used with the extension probe installed, then the maximum vibration frequency to be measured is 16,000 CPM. If the magnetic pickup holder is used to hold the pickup to the rotating machine, then the maximum vibration frequency to be measured is 37,000 CPM.

An optional magnetic shield, Part No. 10449, can be used along with the 544 Velocity Pickup to reduce the magnetic interference. The shield fits over the pickup, and is held by the mounting adapter supplied with the shield.

If desired, vice-grip pliers, Part No. 1821, can be used to hold the velocity pickup to the rotating machine for balancing. The pickup stud mounts to the vice-grip pliers, and the plier jaws must be securely clamped to the rotating machine. The vice-grip pliers provide an item of convenience for balancing, and should not be used when measuring the machine vibration, because the maximum measurable frequency is 7200 CPM when the pliers are used.

3.4 CABLE CONNECTIONS

PICKUP CABLE: The threaded connector at the external end of the cable connects to the threaded receptacle at the top end of the Model 544 Accelerometer, or 544 Velocity Pickup. This connector

should be aligned with the guide key and contact pins in the receptacle, and then hand tightened to the receptacle. The twist-lock connector at the other end of the cable connects to the twist-lock receptacle at the top end of the instrument. This connector should be aligned with the receptacle, and then turned clockwise approximately one full turn (see Chapter II, Sections 2.4.1 and 2.4.2 for details on selection or pairing of the pickup cables). DO NOT WRENCH EITHER PICKUP CABLE CONNECTOR.

OSCILLOSCOPE/TAPE RECORDER/ANALYZER CABLE: The connector at the instrument end of the cable connects to the threaded receptacle at the bottom end of the instrument. The connector at the external end of the cable connects to the signal receptacle on the optional oscilloscope, tape recorder, or analyzer. Connector No. MS 106E108-48, Part No. 5847, is required at the instrument end of this cable. The signal output at the SCOPE receptacle is the conditioned vibration signal voltage. Its full-scale level is 764 mv, rms, in English units, and 301 mv, rms, in Metric units.

USE OF MODEL 810, 810M, or 811 TO PROVIDE ACCELERATION CAPABILITY ON IRD ANALYZER: The Model 810, 810M, or 811 Spike Energy Checker can be used to provide the acceleration measurement on most IRD analyzers. To do this, connect the threaded connector of the analyzer velocity pickup cable to the output receptacle of the Spike Energy Checker. Set the analyzer to VELOCITY, and to the "1" AMPLITUDE RANGE ("10" in Metric units). Set the Spike Energy Checker to the "ACCEL" mode, and adjust its AMPLITUDE SELECTOR to obtain an on-scale indication on the AMPLITUDE METER of this instrument.

Proceed with the frequency analysis as instructed for the analyzer being used. The values obtained on the analyzer AMPLITUDE METER are based on the amplitude range setting of the Spike Energy Checker. Although the analyzer is set to the "1" AMPLITUDE RANGE ("10" in Metric units), the full-scale value obtained on the analyzer AMPLITUDE METER will be identical to the full-scale value of the Spike Energy Checker.

IV OPERATION

4.1 GENERAL

The Vibration-Spike Energy Detector is designed to measure overall vibration, amplitude and spike energy in machine bearings and high speed gears. All vibration readings obtained with this instrument should be compared to known standards of vibration for the type of machine, part, bearing or gear being checked. If the vibration level has increased since the most recent preceding measurement, or exceeds the permissible vibration limit, then mechanical trouble is indicated in the machine.

The majority of rotating machine vibrations are caused by unbalance, defective bearings, misalignment, or mechanical looseness. For this reason, the vibration pickup should be mounted at or close to the machine bearing housing. If the desired bearing housing is not accessible, the pickup can be mounted on the machine structure or support located as close as possible to the bearing.

If the vibration pickup cannot be installed as instructed in Chapter III, then it can be used with a magnetic pickup holder, or hand held with or without an extension probe. However, the measurable vibration frequencies will be reduced as explained in Chapter III.

If the vibration is to be measured quickly at many places on the rotating machine, then the pickup should be held by hand. If vibration measurements are required at places not readily accessible, then the extension probe should be installed to the pickup to provide easier and safer access to these places.

This chapter contains instructions on setup of the instrument, and includes general instructions on measuring vibration, determining the severity and dominant frequency of the vibration, classifying

the vibration, and step-by-step instructions on in-place balancing.

4.2 SETUP

1. Prepare the Vibration-Spike Energy Detector for operation as instructed in Chapter III.

2. Set the instrument POWER SWITCH to ON.

3. Set the MODE SELECTOR to the desired measuring units.

4. Set the AMPLITUDE SELECTOR to the desired full-scale range.

NOTE: Initially, the AMPLITUDE SELECTOR should be set to the least sensitive range, and then progressively to more sensitive ranges until the level of vibration indicated is equal to 1/3 the full-scale value of the AMPLITUDE METER range, or greater. Instructions on correct reading of the meter scales for the various ranges of amplitude are included in Chapter II. In addition, the measuring units to be used for measurement in the various modes (DISPLACEMENT, VELOCITY, ACCELERATION, BEARING/GEAR, AND ISO) are also explained in Chapter II.

4.3 VIBRATION MEASUREMENT

The vibration should be measured in the vertical, horizontal, and axial plane of each bearing housing. The machine vibration levels are indicated on the AMPLITUDE METER. The meter contains two scales, and are explained in Chapter II.

All pertinent rotating mahcine information, plus the vibration readings should be reocrded in a data sheet similar to that shown in Figure 4-1. The recorded data is used to determine the general operating condition of the rotating machine. In addition, it also provides a permanent record of the machine condition.

Figure 4-1 Typical Vibration Data Sheet

4.4 DETERMINING VIBRATION SEVERITY

The vibration readings obtained from the rotating machine should be compared to the tolerances suggested in Table 4-1; to the Vibration Severity Charts in Figures 4-2, 4-3, and 4-4; or to previous vibration readings obtained from the same machine and pickup locations. If the vibration level is too high, trouble may be indicated in the machine, and further checking is needed, as discussed in this chapter.

The acceptable vibration displacement levels for various machine tools are listed in Table 4-1. If the machine vibration level is within the range listed in the table (or if the vibration level has not increased since the preceding measurement), then no trouble is indicated.

The vibration severity of rotating machines not included in Table 4-1 can be determined by relating the vibration velocity of the machine to the appropriate Vibration Severity Chart in Figure 4-2, 4-3, or 4-4. English units are shown in Figure 4-2, and Metric units are shown in Figures 4-3 and 4-4.

The vibration amplitude in displacement, velocity, and acceleration are used to determine the severity of the vibration. These units supply the measurement used to determine whether or not the machine is operating correctly. The greater the vibration amplitude, the more severe the vibration.

The measuring units displacement, velocity, and acceleration are interrelated to one another. However, the velocity measuremnet is independent of frequency, and supplies direct indication of the vibration severity. The velocity measurement generally provides the best indicator of machine condition. The vibration amplitude should be obtained in velocity and in whatever other units are desired. Measurement in displacement or accelera-

tion will provide indication of the vibration severity only if the machine rotating speed is also known.

TABLE 4-1 SUGGESTED MACHINE TOOL VIBRATION LEVELS

MACHINE TOOL VIBRATION DISPLACEMENT TOLERANCES	
TYPE OF MACHINE	TOLERANCE RANGE IN MILS
GRINDERS:	
A. THREAD	0.01 to 0.06
B. PROFILE/CONTOUR	0.03 to 0.08
C. CYLINDRICAL	0.03 to 0.10
D. SURFACE (Vert. Disp.)	0.03 to 0.2
E. GARDNER/BESLEY	0.05 to 0.2
F. CENTERLEGS	0.04 to 0.1
BORING MILL	0.06 to 0.1
LATHE	0.20 to 1.0

NOTE: The above tolerance ranges consist of the high and low vibration displacement values of the machine at which acceptable parts can generally be produced, and are supplied as a guide for judging the indicated vibration as a warning of impending trouble. The measurements were obtained with the vibration pickup mounted on the spindle bearing housing, in the direction of the machine cutting.

Since the vibration velocity is consistent with rotational speed, this measuring unit is listed in each Vibration Severity Chart in Figures 4-2, 4-3, and 4-4 (see Pages 4-7, 4-8, and 4-9). If the vibration severity value read from either of these charts is too high, then trouble may exist in the machine, as explained in Section 4.5.

The SPIKE ENERGY circuits are completely independent of RMS vibration components detected by the displacement, velocity, or acceleration measure-

ment; and are used for detection of deteriorating and defective machine bearings and gear teeth. The SPIKE ENERGY level is indicated on the AMPLITUDE METER, and the acceptable level for most machines operated from 600 to 3600 PRM is 0.5 g, maximum. If the SPIKE ENERGY level is 0.5 g, or higher, the corresponding bearing or gear may be defective. Whether or not the bearing or gear is defective must be verified by experience and observation of the machine trends, since individual machines may have different vibration response characteristics. The acceptable level of SPIKE ENERGY for machines whose operating speed is outside the 600 to 3600 RPM range should be developed individually from the manufacturer's recommended specifications, comparison to similar machines, and from careful study of the vibration amplitude trends of the machine.

4.5 DETERMINING DOMINANT VIBRATION FREQUENCY

If a single vibration frequency is dominant in the machine vibration, the Vibration-Spike Energy Detector can be used to determine the dominant vibration frequency. If the vibration level indicated on the Amplitude Meter does not fluctuate more than ±5% of the full-scale value, the dominant vibration frequency can generally be computed by dividing the vibration displacement level into the vibration velocity level, and multiplying the resulting quotient times the constant 19, 120, as shown in Equation 1, which follows:

EQUATION 1:

$$\text{DOMINANT FREQUENCY (CPM)} = \frac{\text{VEL}}{\text{DISP.}} (19{,}120)$$

NOTE: In English units, velocity is measured in inches per second, peak; and displacement is measured in mils, peak to peak. In Metric units, velocity is measured in millimeters per second, peak; and displacement is measured in micrometers, peak to peak.

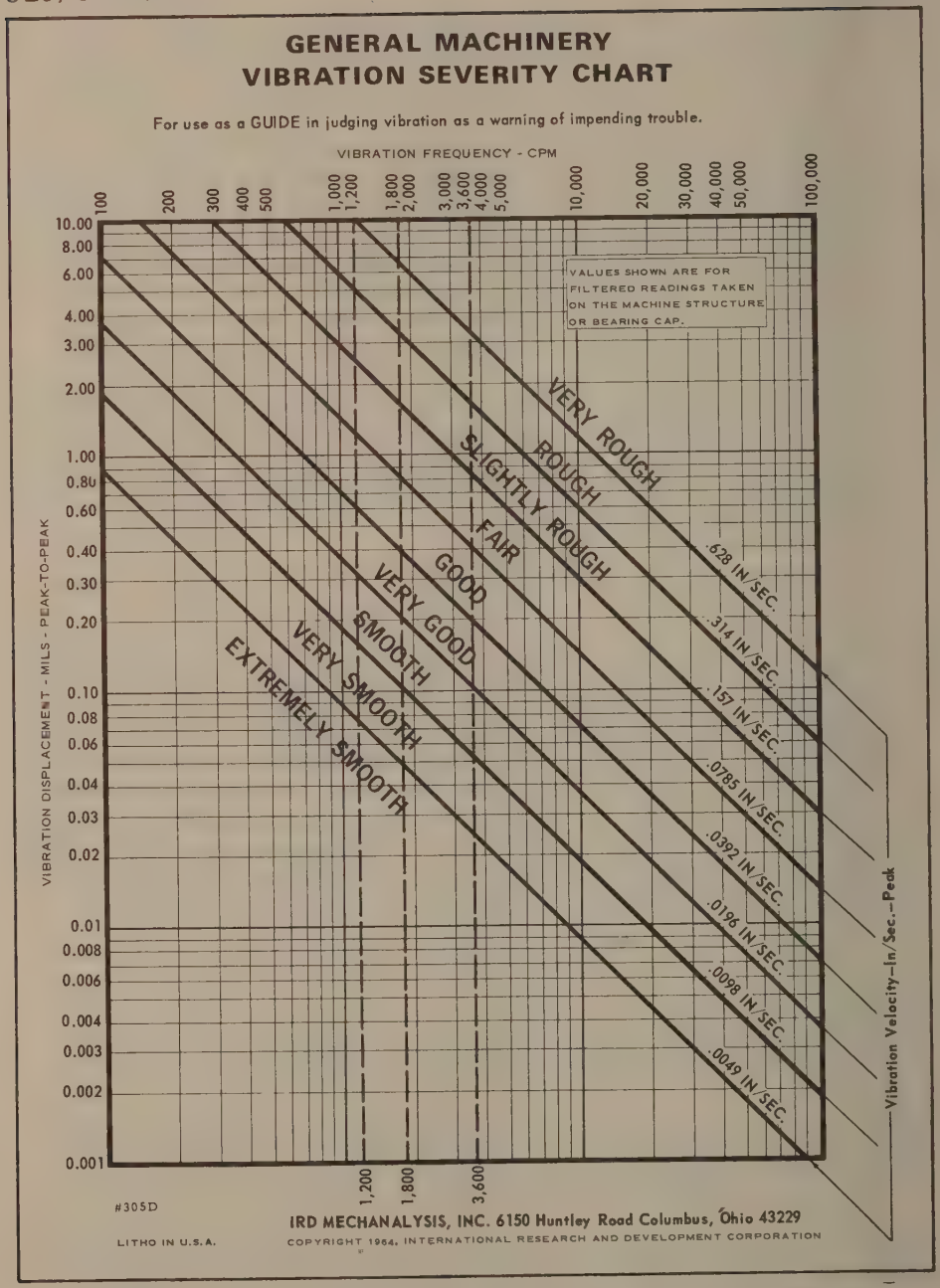


Figure 4-2 Vibration Severity Chart in Mils

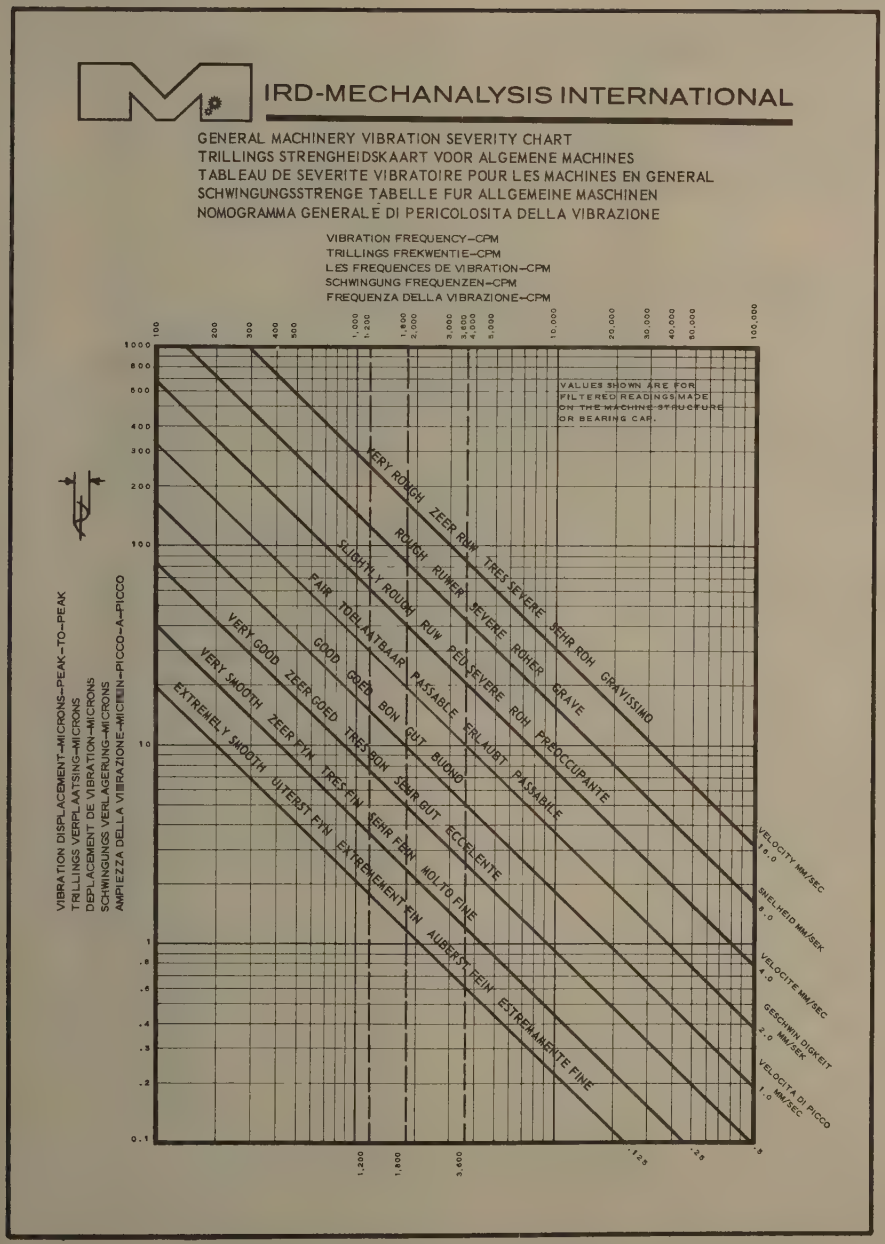

IRD-MECHANALYSIS INTERNATIONAL
GENERAL MACHINERY VIBRATION SEVERITY CHART
TRILLINGS STRENGHEIDSKAART VOOR ALGEMENE MACHINES
TABLEAU DE SEVERITE VIBRATOIRE POUR LES MACHINES EN GENERAL
SCHWINGUNGSSTRENGE TABELLE FUR ALLGEMEINE MASCHINEN
NOMOGRAMMA GENERALE DI PERICOLOSITA DELLA VIBRAZIONE
VIBRATION FREQUENCY—CPM
TRILLINGS FREKWENTIE—CPM
LES FREQUENCES DE VIBRATION—CPM
SCHWINGUNG FREQUENZEN—CPM
FREQUENZA DELLA VIBRAZIONE—CPM
VALUES SHOWN ARE FOR FILTERED READINGS MADE ON THE MACHINE STRUCTURE OR BEARING CAP.
VERY ROUGH ZEER RUW TRES SEVERE SEHR ROH GRAVISSIMO
ROUGH RUWER SEVERE ROHER GRAVE
SLIGHTLY ROUGH RUW PEU SEVERE ROH PREOCCUPANTE
FAIR TOELAATBAAR PASSABLE ERLAUBT PASSABILE
GOOD GOED BON GUT BUONO
VERY GOOD ZEER GOED TRES BON SEHR GUT ECCELENTE
VERY SMOOTH ZEER FYN TRES FIN SEHR FEIN MOLTO FINE
EXTREMELY SMOOTH UITERST FYN EXTREMEMENT FIN AUBERST FEIN ESTREMAMENTE FINE
VIBRATION DISPLACEMENT—MICRONS—PEAK-TO-PEAK
TRILLINGS VERPLAATSING—MICRONS
DEPLACEMENT DE VIBRATION—MICRONS
SCHWINGUNGS VERLAGERUNG—MICRONS
AMPIEZZA DELLA VIBRAZIONE—MICRON—PICCO-A-PICCO
VELOCITY MM/SEC 16.0
SNELHEID MM/SEK 8.0
VELOCITE MM/SEC 4.0
GESCHWIN DIGKEIT 2.0 MM/SEK
VELOCITA DI PICCO 1.0 MM/SEC

Figure 4-3 Vibration Severity Chart in Micrometers

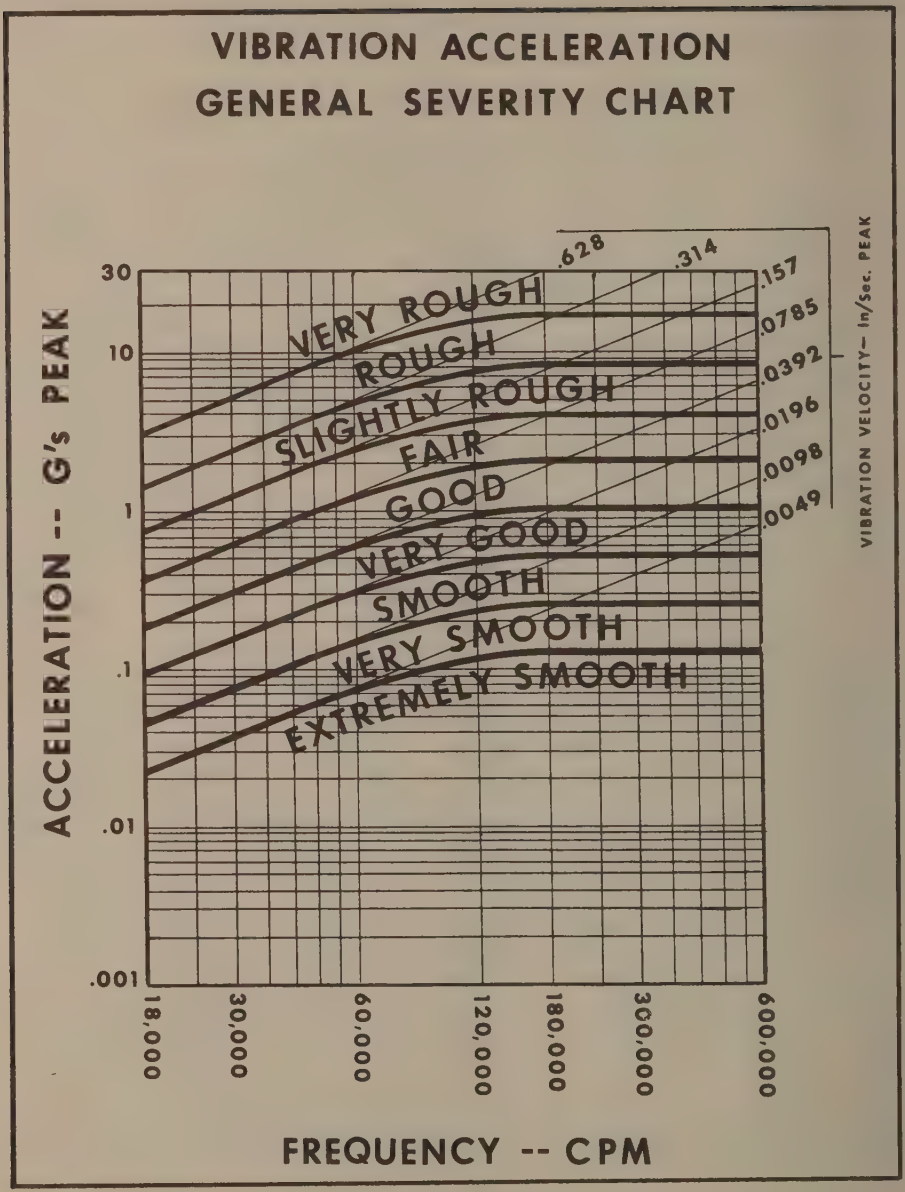


Figure 4-4 Vibration Severity Chart in Acceleration

For Example, if a given belt-driven blower has a motor speed of 1750 CPM, and a fan speed of 2600 CPM; and vibration readings of 0.255 in/sec, peak (velocity), and 1.85 mils, peak to peak (displacement) are obtained at the fan bearing; then the dominant vibration frequency would be computed from Equation 1 as follows:

$$\text{DOMINANT FREQUENCY (CPM)} = \frac{0.255 \text{ in/sec}}{1.85 \text{ mils}} (19{,}120)$$

DOMINANT FREQUENCY = 2639 CPM.

Since the dominant vibration frequency (2639 CPM) is closer to the fan speed (2600 CPM) than to the motor speed (1750 CPM), the fan is more likely the cause of the excessive vibration.

The dominant vibration frequency can also be determined from the chart in Figure 4-5, by relating the vibration velocity and displacement values obtained on the AMPLITUDE METER to this chart (see Figure 4-5 on Page 4-11).

The dominant vibration frequency value can often be used to determine the machine part cuasing the vibration. This frequency could occur at the rotating speed of the faulty part, at a multiple of the rotating speed, or at some other frequency.

In the blower discussed above, if the vibraiton is measured at either motor bearing, the vibrations include the motor vibrations plus all other vibrations transmitted via the drive belt and the blower structure from the fan. Or, if the vibration is measured at a fan bearing, the vibrations include the fan vibrations plus all vibrations transmitted by the drive belt and blower structure from the motor. To insure adequate definition of the machine vibrations, the measurements should generally be obtained from each bearing housing.

When the dominant frequency of the vibration has

been determined, the Table 4-2 data can be used to help identify the specific problem. However, one must remember that only a preliminary identification of the vibration can be accomplished by using a Model 810, 810M, or 811 instrument. A positive confirmation of the diagnosis requires a vibration analyzer, such as an IRD Model 350, 360, 840, or 850/860.

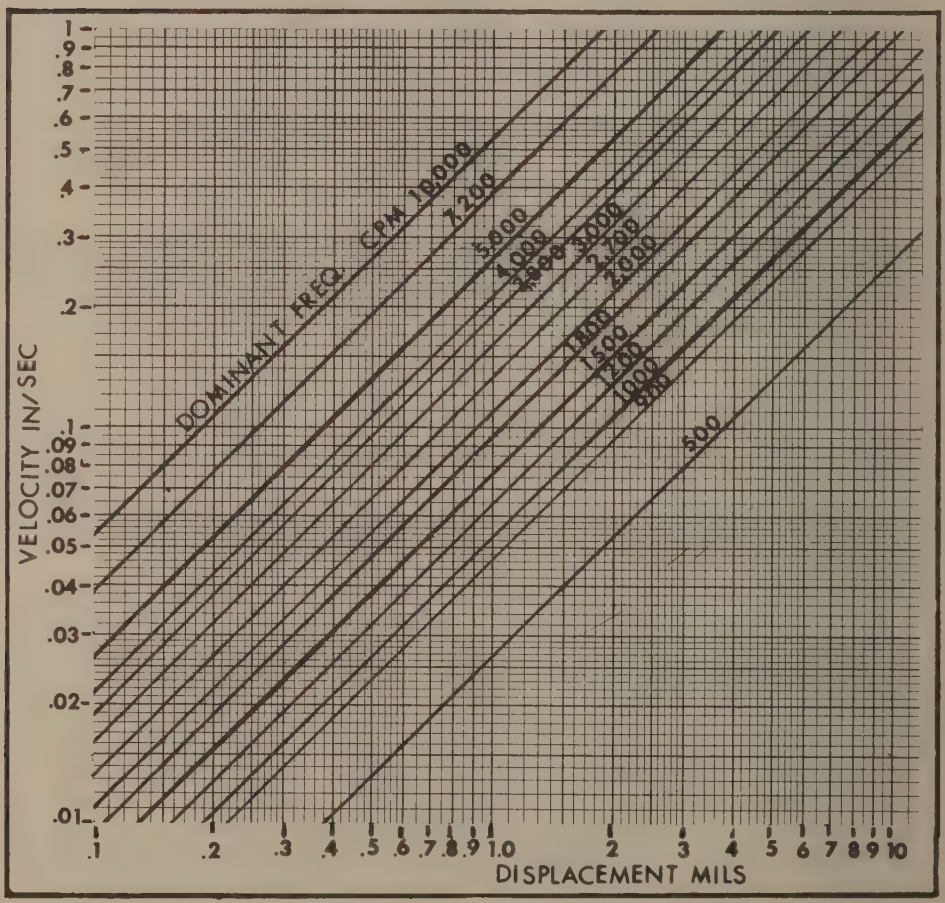


Figure 4-5 Dominant Vibration Frequency Chart

TABLE 4-2 VIBRATION FREQUENCIES AND CAUSES

Frequency In Terms Of RPM	Most Likely Causes	Other Possible Causes & Remarks
1 x RPM	Unbalance	1) Eccentric journals, gears or pulleys 2) Misalignment or bent shaft — if high axial vibration 3) Bad belts if RPM of belt 4) Resonance 5) Reciprocating forces 6) Electrical problems
2 x RPM	Mechanical Looseness	1) Misalignment if high axial vibration 2) Reciprocating forces 3) Resonance 4) Bad belts if 2 x RPM of belt
3 x RPM	Misalignment	Usually a combination of misalignment and excessive axial clearances (looseness).
Less than 1 x RPM	Oil Whirl (Less than ½ RPM)	1) Bad drive belts 2) Background vibration 3) Sub-harmonic resonance 4) "Beat" Vibration
Synchronous (A.C. Line Frequency)	Electrical Problems	Common electrical problems include broken rotor bars, eccentric rotor, unbalanced phases in poly-phase systems, unequal air gap.
2 x Synch. Frequency	Torque Pulses	Rare as a problem unless resonance is excited
Many Times RPM (Harmonically Related Freq.)	Bad Gears Aerodynamic Forces Hydraulic Forces Mechanical Looseness Reciprocating Forces	Gear teeth times RPM of bad gear Number of fan blades times RPM Number of impeller vanes times RPM May occur at 2, 3, 4 and sometimes higher harmonics if severe looseness
High Frequency (Not Harmonically Related)	Bad Anti-Friction Bearings	1) Bearing vibration may be unsteady — amplitude and frequency 2) Cavitation, recirculation and flow turbulence cause random, high frequency vibration 3) Improper lubrication of journal bearings (Friction excited vibration) 4) Rubbing

4.6 IN PLACE BALANCING

Unbalance is the most common cause of vibration in rotating machines, and the vibration resulting from unbalance can be determined. This section contains instructions for in-place balancing of rotating machines using a Model 810, 810M, or 811 instrument. To balance a rotating machine, the machine must be stopped and restarted several times.

Locations for attaching balancing weights are now

provided on many types of rotating machines,and the locations for mounting these weights are generally included in the manufacturer specifications. On some machines, methods such as bolting or welding the weights to various machine parts are used. In addition, provisions for removal of existing weights for balancing are provided in some cases. The in-place balancing is performed as follows:

NOTE: If possible, a Vibration Analyzer/Dynamic Balancer such as an IRD Mechanalysis Model 350, 360, 840, or 850/860 should be used for the balancing since these instruments contain a tunable filter, and an external strobe light which provides separation of the various vibration frequency components. However, the machine can be balanced with a Model 810, 810M, or 811 instrument under the following conditions:

a. Unbalnace must be the main cause of the vibration (check to make certain that other causes such as misalignment of couplings or bearings, bent shafts, defective anti-friction bearings, defective gears, or mechanical looseness, etc., are not present before attempting to balance).

b. The vibration indication must be steady (the meter indicator must not fluctuate or drift more than ±5% of full-scale).

c. The dominant frequency of the vibration must be equal to the rotating speed of the part to be balanced.

If the above three conditions are met, the machine can be single-plane balanced as explained below:

Balancing Procedure

1. Install the acceleromater/velocity pickup at or near the machine bearing having the higher vibration (long axis of the pickup

must be positioned in the same direction as the rotating machine vibration displacement).

2. Measure and record the original unbalance vibration amplitude as value "O".

3. Stop the rotating machine, then prepare a Trial Weight "TW", and install this weight at a known angle and radius (record the weight value).

4. Restart the rotating machine and allow it to come up to the normal operating speed.

5. Measure and record the new unbalance vibration value as value "T1".

6. Stop the rotating machine, then move the Trial Weight 180° from the original position (Step 3) at the same radius value.

7. Restart the rotating machine and allow it to come up to the normal operating speed.

8. Measure and record the new unbalance vibration value as value "T2".

9. Construct a vector diagram as illustrated in Figure 4-6, by using the "O", "T1", and "T2" values obtained in Steps 2, 5, and 8 for the rotating machine being balanced. (A scaling of 0.4 inch per mil of unbalance is used in Figure 4-6).

10. In the vector diagram, project a vertical line through the original circle, and label the intersection at 0° as Point "A", and the intersection at 180° as Point "B".

11. At the same scaling used in Step 9, draw an arc at radius "T1" from Point "A", as illustrated (use the "T1" value obtained in Step 5).

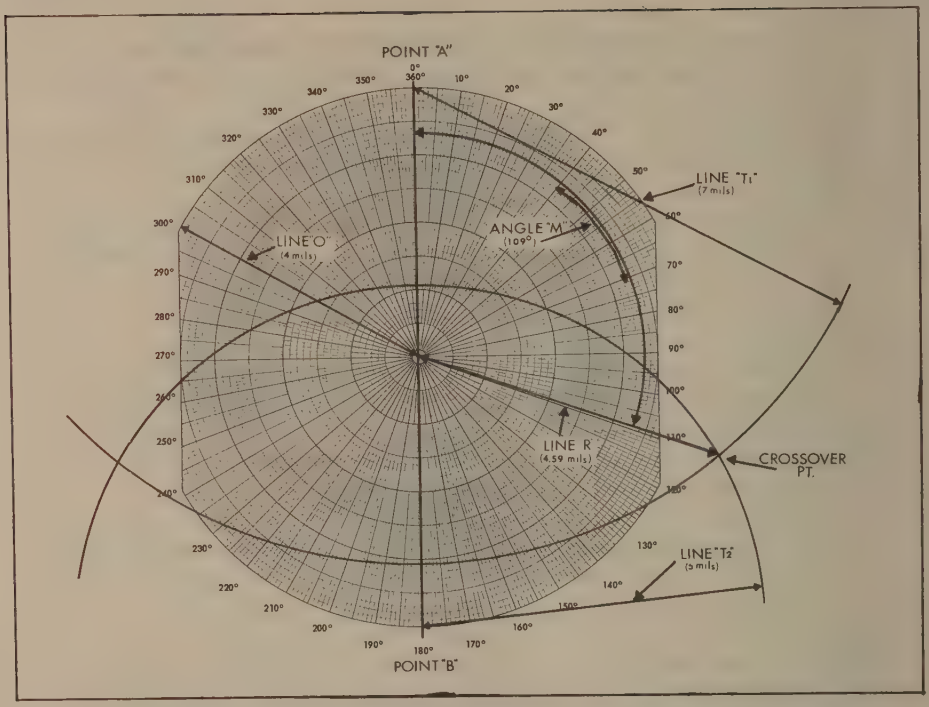


Figure 4-6 Sample Balancing Vector Diagram

12. At the same scaling used in Step 9, draw an arc at radius "T2" from Point "B", as illustrated (use the "T2" value obtained in Step 8).

NOTE: The radius lines projected in Steps 11 and 12 will cross one another at two points located an equal angular distance from Point "A".

13. Project a straight line from the center of the vector diagram to either cross-over point of the radius-line projections drawn in Steps 11 and 12, and label as Line "R".

14. Compute the final amount of correction weight required from Equation 2, which follows.

EQUATION 2:

$$\text{REQUIRED CORRECTION WEIGHT} = \frac{\text{"O"} + \text{"TW"}}{\text{"R"}}$$

(Value "O" was obtained in Step 2, value "TW" in Step 3, and value "R" in Step 13).

NOTE: In Figure 4-6, the "O" value is 4 mils (original unbalance), the "TW" value is 20 mils, and the "R" value (unbalance at the intersection of the two arcs) is 4.59 mils. If these values were obtained for the rotating machine being balanced, then the amount of correction weight required for balancing the machine would be computed from Equation 2 as follows:

$$\text{REQUIRED CORRECTION WEIGHT} = \frac{4.0 \text{ mils} + 20 \text{ grams}}{4.59 \text{ mils}}$$

REQUIRED CORRECTION WEIGHT = 17.4 grams.

15. With a protractor, measure the angular distance from where Line "R" and the two arc lines intersect to Point "A". The angle at which Line "R" is drawn is angle "M", and in Figure 4-6 equals 109°.

16. Fabricate a correction weight to the gram weight computed from Equation 2, and install on the rotating machine at the point located clockwise from the original "TW" position (see Step 3) by angle "M" degrees, at the same radius used in Step 3.

17. Start the rotating machine and allow it to come up to the normal rotating speed.

18. Measure the machine unbalance, if the desired balancing is obtained, then the correction weight is correctly installed; otherwise, proceed with Step 19.

19. Stop the rotating machine, then move the weight counter clockwise from the original "TW" position (see Step 3) by the angle "M" degree value determined in Step 15.

20. Restart the rotating machine, and allow it to come up to the normal rotating speed.

21. Measure the machine unbalance, if the desired balancing is obtained, the correction weight is correctly installed, and the rotating machine is properly balanced.

V SERVICE

5.1 CIRCUIT DESCRIPTION AND OPERATION

A simplified block diagram of the Model 810, 810M, and 811 circuits is shown in Figure 5-1, and a detailed diagram of these circuits is shown in Figure 5-2. References to these illustrations are used throughout this section.

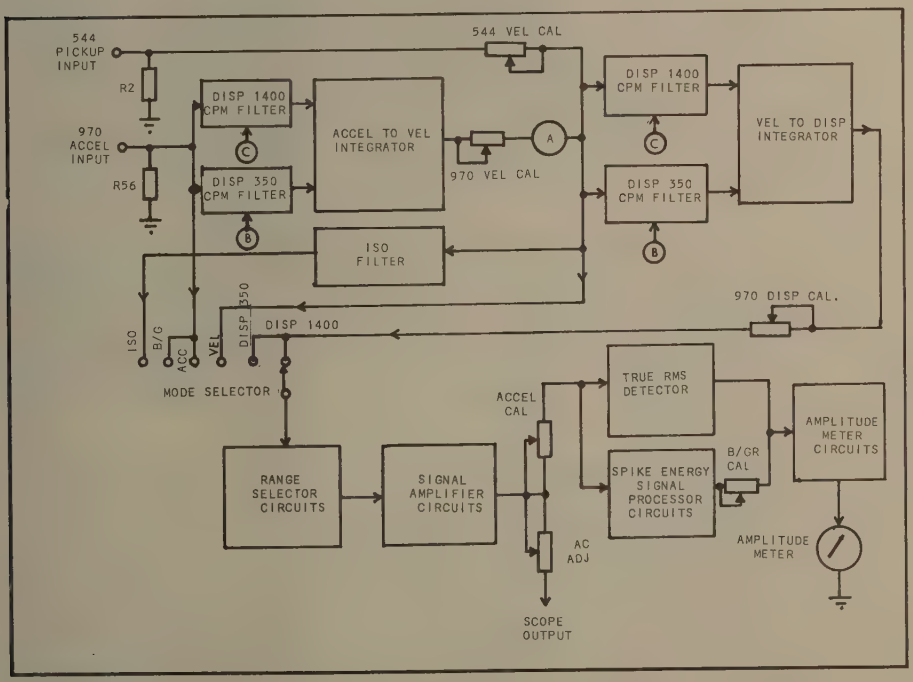


Figure 5-1 Simplified Block Diagram

5.1.1 OPERATIONAL MODES

DISPLACEMENT 1400 OR 350 CPM MODE: In either the Displacement 1400 or 350 CPM Mode, the input from the 970 Accelerometer is received by the ACC to VEL integrator. This integrator converts the ACCELERATION input signal into a VELOCITY signal. The output from this integrator is further processed by the VEL to DISP integrator which converts the signal voltage into a DISPLACEMENT, peak to peak, voltage.

In the DISPLACEMENT 1400 CPM MODE (see Figure 5-2 electronic couplers A and C are both energized. Coupler A connects the signal voltage to the VEL to DISP integrator, and coupler C connects the circuit components required for filtering out the vibration signal frequency components below 1400 CPM.

In the DISPLACEMENT 350 CPM MODE (see Figure 5-2) electronic couplers A and B are both energized. Coupler A connects the signal voltage to the VEL to DISP integrator. Coupler B connects the circuit components required for passing the entire spectrum of vibration frequency components down to 350 CPM through the integrator.

In both DISPLACEMENT MODES (see Figure 5-2), the input signal level, the 970 VEL CAL setting, and the 970 DISP CAL setting determine the level of the displacement signal voltage provided at the output of IC5B. When both of these controls have been set up correctly, an output signal level of 35.4 mv, rms, is obtained at IC5B with an input signal level 35.4 mv, rms, 139.8 Hz, connected from the accelerometer.

If a Model 544 Pickup is used, the pickup input cable wiring will deenergize electronic coupler A. Since this pickup supplies a velocity input signal voltage, only one integration is required to obtain the conversion into a displacmeen: signal voltage. In the DISPLACEMENT 1400 CPM MODE,

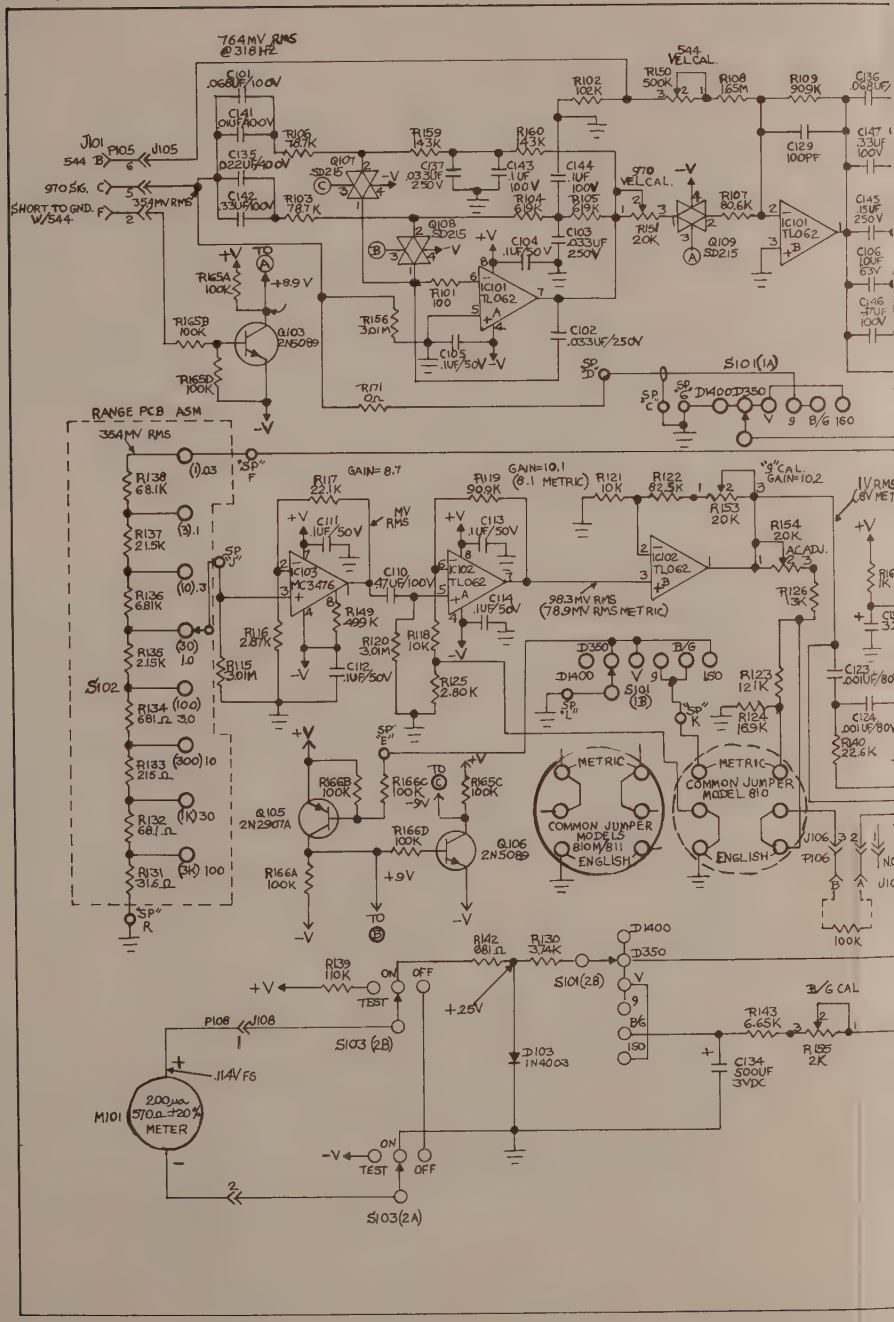
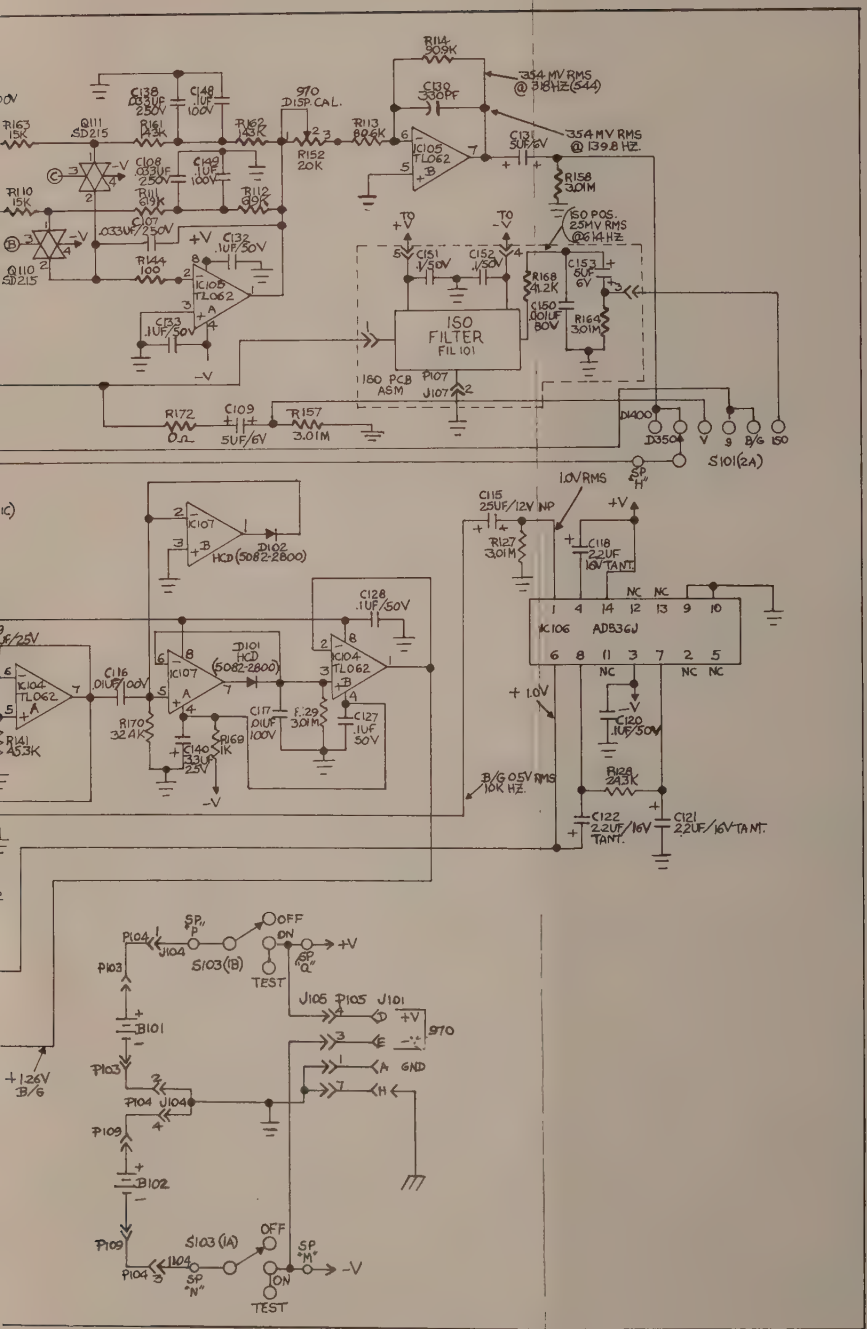


Figure 5-2 Instrument Circuit Diagram


R114 309K
354 MV RMS @ 318 HZ (5&4)
C130 330PF
970 DISP. CAL.
C138 .033UF 250V
C148 .1UF 100V
R163 15K
R111 SD215
R161 453K
R162 453K
R152 20K
R113 806K
IC105 TLO62
354 MV RMS @ 139.8 HZ.
C131 .1UF/6V
C108 .033UF 250V
C149 .1UF 100V
R158 3.01M
R110 15K
R159 619K
R112 909K
C107 .033UF/250V
+V
C132 .1UF/50V
TO +V
TO -V
150 POS. 25MV RMS @ 6.14 HZ.
R144 100
IC108 TLO62
C151 .1/50V
C152 .1/50V
C153 6UF 6V
R168 4.2K
C150 .001UF 80V
R169 3.01M
C133 .1UF/50V
150 FILTER FIL 101
-V
150 PCB ASM
P107
J107
R172 0.2
C109 5UF/6V
R157 3.01M
D1400
D1350
V
9
B/G
150
S101(2A)
SP "H"
1.0V RMS
C115 25UF/12V NP
+V
R127 3.01M
C118 2.2UF 16V TANT.
IC107
D102 HCD (5082-2800)
C128 .1UF/50V
NC NC
1 4 14 12 13 9 10
IC106 AD536J
6 8 11 3 7 2 5
NC NC NC
IC104 TLO62
C116 .01UF/100V
D101 HCD (5082-2800)
IC107
IC104 TLO62
+ 1.0V
R170 324K
C117 .01UF/100V
R129 3.01M
C127 .1UF 50V
R169 1K
C140 33UF 25V
-V
C120 .1UF/50V
B/G 0.5V RMS 10K HZ.
R128 243K
C122 2.2UF/16V TANT.
C121 2.2UF/16V TANT.
SP "P"
OFF
ON
TEST
S103(1B)
+V
SP "Q"
P104
J104
P103
J105 P105 J101
970
B101
GND
P109
B102
S103 (1A)
SP "M"
SP "N"
-V
+12.6V B/G

electronic coupler C is energized, and vibration frequency components below 1400 CPM are filtered out of the input signal voltage. In the DISPLACEMENT 350 CPM Mode, electronic coupler B turns on, and all vibration frequency components down to 350 CPM are included in the output signal voltage. At 318 Hz input frequency, the 544 Pickup input is 764 mv, rms, per inch per second, peak in Model 810 (902 mv, rms, per 30 mm per second, peak in Model 810M or 811). When the 544 VEL CAL and 970 DISP CAL controls are set up correctly, an output level of 35.4 mv, rms, is output at IC5B with an input signal level of 764 mv, rms, at 318 Hz connected at the 544 Pickup input terminals of the instrument.

VELOCITY MODE: In the Velocity Mode, the ACC to VEL integrator receives the Model 970 Accelerometer input signal. This integrator converts the input signal from ACCELERATION into VELOCITY. In this mode, electronic couplers A and B are both energized. Coupler A connects the output of the integrator to IC1B (Fig. 5-2), and coupler B connects the required circuit components for inclusion of the vibration frequency components down to approximately 350 CPM in the signal voltage. When the 970 VEL CAL control is set up correctly, an output signal level of 35.4 mv, rms, is provided at IC1B with an input of 35.4 mv, rms, @ 61.4 Hz, connected at the 970 Accelerometer input terminals.

If a Model 544 Pickup is used in the VELOCITY MODE, the input signal voltage is in velocity form, and no integration is used. In this case, the signal voltage provided at the IC1B output (Fig. 5-2) is proportional to the level of the input supplied by the 544 Pickup, and determined by the setting of the 544 VEL CAL control. With an input of 764 mv, rms, connected at the 544 Pickup terminals, an output signal level of 35.4 mv, rms, will be obtained at IC1B output, when the 544 VEL CAL control is set up correctly.

ACCELERATION MODE: In the Acceleration Mode, the Model 970 Accelerometer signal input voltage to the instrument is in ACCELERATION, and is connected to the RANGE SELECTOR circuits by the MODE SELECTOR switch, S101-C (Fig. 5-2). The input signal level is 35.4 mv, rms, per g of acceleration. Operation of the RANGE SELECTOR circuits is explained in Section 5.2.1.

BEARING-GEAR g's S.E. MODE: In the Bearing-Gear g's S.E. Mode, the Model 970 Accelerometer input signal is connected to the RANGE SELECTOR circuits by the MODE SELECTOR switch, S101-C. This input signal level is 35.4 mv, rms, at 10,000 Hz. per g of spike energy. Operation of the RANGE SELECTOR circuits is explained in Section 5.2.1.

ISO MODE: In the I.S.O. Mode (International Standard Organization), which is provided only in the Model 811 Instrument, the Model 970 Accelerometer is used. The ACC to VEL integrator receives the input signal, and converts it into VELOCITY. With an input signal of 50, mv, rms, an output of 35.4 mv, rms, is provided at the ISO output terminals.

5.1.2 RANGE SELECTOR CIRCUITS

The RANGE SELECTOR CIRCUITS receive the processed signal voltage of the selected operational mode. This signal voltage is connected by the MODE SELECTOR switch S102-C for measurement of vibraiton DISPLACEMENT, VELOCITY, ACCELERATION, BEARING-GEAR SPIKE ENERGY, or ISO RMS VELOCITY (Model 811 only). These circuits contain eight resistors and a selector switch. The resistors are connected in series with one another, and the junction points are connected to contacts of the RANGE SELECTOR switch to provide eight selectable measuring sensitivity settings, or full-scale measuring ranges. The full-scale measuring ranges are listed in Chapter II. The signal output voltage at the arm of the RANGE SELECTOR switch is connected to the SIGNAL AMPLIFIER circuits for amplification to the

required voltage levels. The SIGNAL AMPLIFIER CIRCUITS are discussed in Section 5.1.3.

5.1.3 SIGNAL AMPLIFIER CIRCUITS

The SIGNAL AMPLIFIER CIRCUITS (Figures 5-1 and 5-2) receive the selected signal input voltage from the RANGE SELECTOR SWITCH. An input of 1.12 mv, rms, is connected to these circuits with a RANGE SELECTOR setting of 1 MIL, 1 INCH/SECOND, 1 g, or 30μm or mm. In addition, an input of 0.56 mv, rms, is connected to these circuits with a RANGE SELECTOR setting of 1 g of BEARING-GEAR SPIKE ENERGY. These signal voltages are increased or decreased proportionally if more or less sensitive ranges are selected.

The SIGNAL AMPLIFIER CIRCUITS consist of three stages of amplifiers and two output calibration controls. Amplifier IC103 (Figure 5-2) has a gain of 8.7 (output voltage of 9.74 mv, rms, with an input of 1.12 mv, rms). In Model 810, amplifier IC102A has a gain of 10.1 (output of 98.3 mv, rms, with an input of 9.74 mv, rms). In Model 810M and 811, this amplifier has a gain of 8.1 (output of 78.9 mv, rms, with an input of 78.9 mv, rms). Amplifier IC 102B has a gain of 10.2 in Model 810 (output of 1.0 volt, rms, with an input of 98.1 mv, rms). In Model 810M and 811, this amplifier has an output of 0.8 volt, rms, in the DISPLACEMENT and VELOCITY MODES. The required voltage level at the scope output is obtained by adjustment of the AC CAL control. The output of IC102B is connected to the TRUE RMS DETECTOR (Section 5.1.4), and to the SPIKE ENERGY SIGNAL PROCESSING CIRCUITS explained in Section 5.1.5.

The AC ADJ control is calibrated to provide a known output level for connection to an optional oscilloscope, or tape recorder. This control is calibrated by connecting a 100K load resistor between Pin B of the SCOPE RECEPTACLE and ground. In the Model 810 Instrument, the AC ADJ control is set up for an output of 764 mv, rms, when an input

of 1.12 mv, rms, is connected to the input of IC 103. In Models 810M and 811, this control is set for an output of 301 mv, rms, with the same level of input voltage.

5.1.4 TRUE RMS DETECTOR CIRCUITS

The TRUE RMS DETECTOR CIRCUITS (Fig. 5-2) receive the calibrated output voltage from the SIGNAL AMPLIFIER CIRCUITS, and consist of the TRUE RPM DETECTOR, IC106, and its peripheral components. In Model 810, an input of 1 volt, rms, is connected to these circuits with a full-scale AMPLITUDE setting of 1 mil, 1 in/second, or 1 g of acceleration. In Model 810M or 811, an input of 0.8 volt, rms, is connected to the TRUE RMS DETECTOR circuits with an AMPLITUDE setting of 30 millimeters, and input of 35.4 mv, rms, at 61.4 Hz connected to the instrument. In the ACCELERATION MODE, an input of 1 volt, rms, is connected to these circuits with an AMPLITUDE setting of 1 g, and an input signal of 35.4 mv, rms, connected to the instrument.

The output voltage of IC106 is a dc voltage with a magnitude proportional to the input rms voltage. This output voltage is connected to the AMPLITUDE METER (M101) CIRCUITS by contacts of the MODE SELECTOR switch, S101B. The AMPLITUDE METER CIRCUITS are explained in Section 5.1.6.

5.1.5 SPIKE ENERGY SIGNAL PROCESSOR CIRCUITS

The SPIKE ENERGY SIGNAL PROCESSOR CIRCUITS receive the calibrated signal output voltage connected from the SIGNAL AMPLIFIER CIRCUITS. These circuits provide a dc output voltage proportional to the Spike Energy of the rotating machine. The Model 970 Accelerometer supplies an input signal of 17.7 mv, rms, per 0.5 g's of spike energy at 10,000 Hz to the instrument. With a full-scale AMPLITUDE setting of 1 g, an output of 0.5 volt, rms, is provided at the SIGNAL AMPLIFIER output, and connected to the SPIKE ENERGY SIGNAL PROCESSOR

CIRCUITS. These circuits supply a dc output of approximately +1.26 volts with this input voltage. When the BR-GR CAL CONTROL is correctly calibrated, an indication of 0.5 g of spike energy will be obtained on the AMPLITUDE METER.

5.1.6 AMPLITUDE METER CIRCUITS

The AMPLITUDE METER CIRCUITS receive the dc signal output voltage from the TRUE RMS DETECTOR (IC6, Pin 6) in the DISPLACEMENT, VELOCITY, ACCELERATION, and ISO modes. In the BEARING-GEAR g's SE mode, these circuits receive the dc output voltage of operational amplifier IC104. The AMPLITUDE METER CIRCUITS (see Figure 5-2) consist of resistors R30 and R42, diode D3, contacts of the POWER SWITCH S103, and the AMPLITUDE METER M101.

In the DISPLACEMENT, VELOCITY, ACCELERATION, or ISO mode the input to the AMPLITUDE METER CIRCUITS comes from IC106 (Pin 6). For a full-scale meter indication in either of these modes, a signal output of approximately 1 volt is provided at IC106. In the BEARING GEAR g SE Mode, the AMPLITUDE METER CIRCUITS receive the output voltage from Pin 1 of amplifier IC104. For an indication of 0.5 g (one-half scale) on the AMPLITUDE METER, an output of approximately +1.26 volts is supplied by IC104.

Diode D103 (Fig. 5-2) limits the voltage between R142 and ground to +0.6 volts to protect the AMPLITUDE METER from overloading. Should the meter voltage tend to rise above +0.6 volts, the diode would conduct heavily, and would, thus, short-circuit the voltage to ground.

5.2 FIELD MAINTENANCE

The Model 810, 810M, or 811 Instrument should require very little field maintenance. The extent of the maintenance provided in the field can vary, depending on the availability of compentent service

personnel and the required electronic test equipment. The following operations can be easily performed in the field without using electronic test equipment:

A. Checking or Replacing Instrument Batteries.
B. Checking Accelerometer Pickup Cable.
C. Checking Instrument Operation with the External Calibrator.

Checking Internal Batteries

To check the internal batteries, set the POWER switch to the BATT TEST position, and check that the AMPLITUDE METER indicates within the LO-BATTERY-HI area on the lower meter scale. If the meter indicates below the LO marker, the batteries must be replaced before the instrument can be used.

Replacing Instrument Batteries

The instrument batteries are replaced as follows (see pictorial guide in Figure 5-3, Page 5-10):

1. Set POWER SWITCH to OFF.

2. Remove the two Phillips-head screws from the small panel on rear side of the instrument, then remove this panel (see Reference A).

3. Remove the plastic cover from the internal batteries (Reference B).

4. Remove the batteries, and disconnect each snap-on contactor (Reference C thru F).

5. Replace the batteries with 8.4 V. mercury battery, Part No. 9291.

6. Reassemble in the reverse order.

7. Check the batteries for proper output voltage as instructed in preceding paragraph.

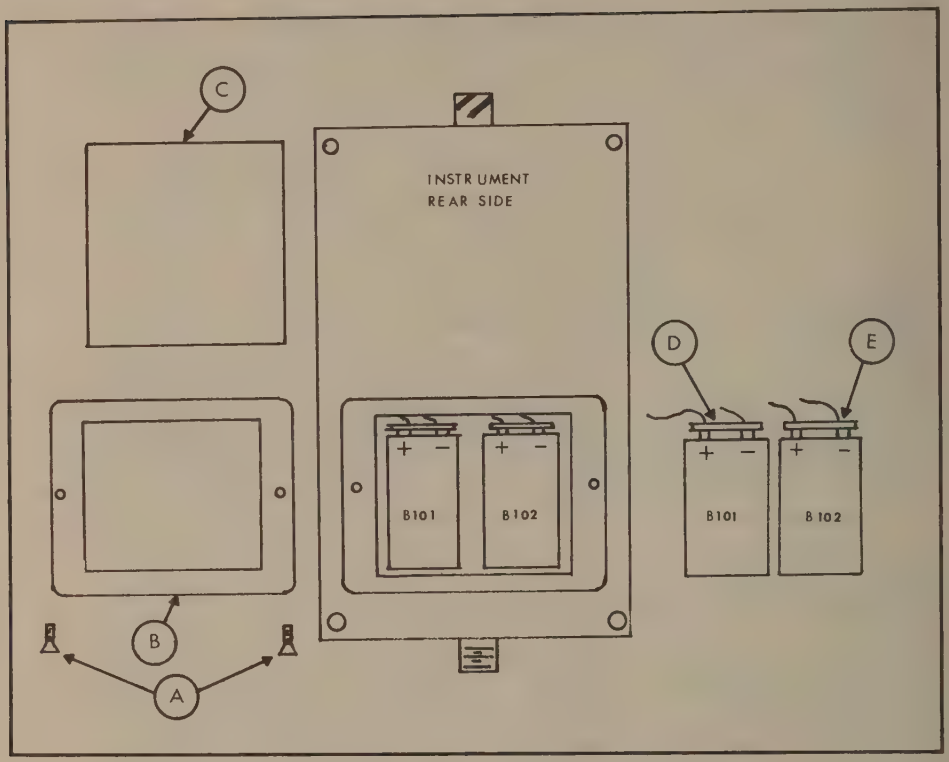


Figure 5-3 Battery Replacement Details

Checking Pickup Input Cable

Check that the connectors at each end of the cable are correctly assembled to the quick-latch receptacle at the top end of the instrument, and the threaded receptacle at top end of the Model 970 Accelerometer (see details in Chapter 3). Then, with power ON, check the cable for intermittent connections by slight jiggling at ends of the cable/ replace the cable. Check for connection of the vibration pickup input signal by setting the POWER SWITCH to ON, and the RANGE SELECTOR to any high-sensitivity range, and then hand shaking the 970 Accelerometer, or 544 Pickup. The AMPLITUDE METER should indicate vibration when the pickup is moving, and should settle back to zero when the pickup is

still. All worn, damaged, or intermittent cables should be replaced (see replacement part numbers in Section 5-4).

Checking Operation with Calibrator

The instrument circuits, and pickup cable can be checked for proper operation quickly with an optional Calibrator (Part No. 21073). To install the Calibrator, set the POWER SWITCH to OFF, disconnect the external end of the 970 Accelerometer input cable, and connect the cable to the threaded receptacle on the CALIBRATOR. Then check the instrument for proper operation by performing the circuit tests listed in Chapter 3, Page 3-5, of this manual.

5.3 CALIBRATION PROCEDURE

The electronic test instruments and circuit connections required for calibration of the Model 810, 810M or 811 instruments are listed below and illustrated in Figure 5-4. The test instruments should be installed as shown in this illustration. The instrument can then be calibrated by performing the procedures listed in the following steps:

Test Equipment Required

1. AC Signal Generator, H-P No. 202-C, or equivalent.

2. AC-DC millivolt meter, digital, H-P No. 3403-C, or equivalent.

3. One 100,000 ohm precision resistor, IRD Part No. 19694.

NOTE: Figure 5-4 is shown on Page 5-12, and the locations of the Model 810, 810M, or 811 internal components, setup controls, etc., are illustrated in Figure 5-5, Page 5-21.

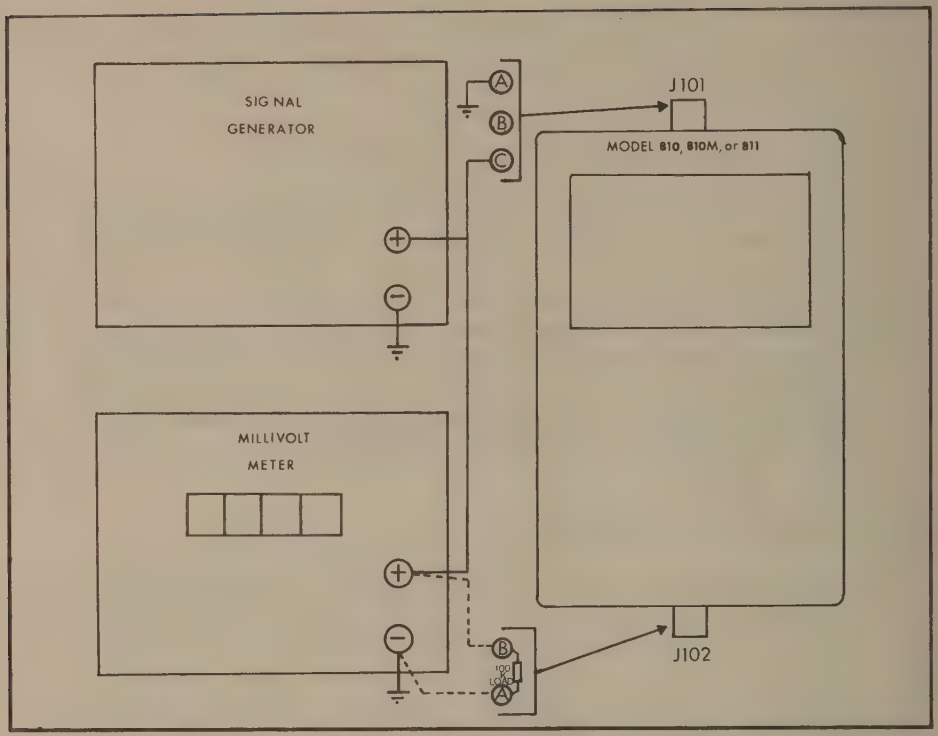


Figure 5-4 Calibration Test Instrument Connections

ACCELERATION CALIBRATION

1. Connect the test instruments to the Model 810, 810M, or 811 instrument as illustrated in Figure 5-4.

2. Set the MODE SELECTOR to ACCELERATION, and AMPLITUDE SELECTOR to the 1 g range.

3. Setup the signal generator for an output voltage of 35.4 mv, rms, and frequency of 61.4 Hz.

4. Connect the 100,000 ohm resistor across Pins A and B of the SCOPE OUTPUT receptacle (J102) as shown in Figure 5-4.

5. Set the instrument POWER SWITCH to ON.

6. Adjust the ACC CAL CONTROL (R153, Fig. 5-5) so that an output level of 1.0 g is indicated on the upper scale of the AMPLITUDE METER.

7. Connect the output signal leads from the SCOPE OUTPUT receptacle to the external test millivolt meter.

8. Adjust the AC OUTPUT CONTROL (R154, Fig 5-5) so that an output of 764 mv, rms, is indicated on the test meter (in Model 810M or 811, adjust control for output of 301 mv, rms).

970 VELOCITY CALIBRATION

1. Set the MODE SELECTOR to VELOCITY, and the AMPLITUDE SELECTOR of Model 810 to 0 to 1 inch/second range (set Model 810M or 811 AMPLITUDE SELECTOR to 0 to 30 mm/second range).

2. Connect the signal voltage leads from the PICKUP receptacle (J101) to the external test millivolt meter (see Figure 5-4).

3. Setup the signal generator for an output voltage of 35.4 mv, rms, and frequency of 61.4 Hz.

4. Adjust the 970 VEL CAL CONTROL (R151, Fig. 5-5) so that an output level of 1.0 inch/second is indicated on the AMPLITUDE METER (25.4 mm/second on Model 810M or 811 meter).

DISPLACEMENT CALIBRATION

1. Set the MODE SELECTOR to DISPLACEMENT 350 CPM, and the AMPLITUDE SELECTOR of Model 810 to the 0 to 1 mil range (set AMPLITUDE SELECTOR of Model 810M or 811 to the 0 to 30 micrometer range).

2. Setup the signal generator for an output voltage of 35.4 mv, rms, and frequency of 139.8 Hz.

3. Adjust the 970 DISP CAL CONTROL (R152, Fig. 5-5) so that an output level of 1.0 mil, peak to peak, is indicated on the AMPLITUDE METER of the Model 810 (25.4 micrometers, peak to peak, on the Model 810M or 811 AMPLITUDE METER).

4. Set the MODE SELECTOR to DISPLACEMENT 1400 CPM, and check that the same output level as obtained in Step 3 is indicated on the AMPLITUDE METER.

BEARING-GEAR g's SE CALIBRATION

1. Set the MODE SELECTOR to BEARING-GEAR g's SE, and the AMPLITUDE SELECTOR to the 1 g range.

2. Setup the signal generator for an output voltage of 17.7 mv, rms, and frequency of 10,000 Hz.

3. Adjust the BEARING-GEAR CAL CONTROL (R155, Fig. 5-5) so that an output level of 0.5 g is indicated on the AMPLITUDE METER.

ISO CALIBRATION (MODEL 811 only)

1. Set the MODE SELECTOR to ISO (International Standards Organization), and the AMPLITUDE SELECTOR to the 0 to 30 millimeter/second range.

2. Setup the signal generator for an output voltage of 35.4 mv, rms, and frequency of 61.4 Hz.

3. Check the AMPLITUDE METER for an indication of 18 millimeters/second, rms, velocity.

544 VELOCITY CALIBRATION

1. Set the POWER SWITCH of the instrument to OFF.

2. Connect the positive (+) signal input lead of the signal generator, and the positive (+) test lead of the millivolt meter to Pin B of the PICKUP receptacle (J101), and connect the negative (-) signal load of each calibration instrument to the instrument ground.

3. Set the MODE SELECTOR to VELOCITY, and the AMPLITUDE SELECTOR of Model 810 to the 1 inch/second range (set AMPLITUDE SELECTOR of Model 810M or 811 to the 30 millimeter per second range).

4. Setup the signal generator for an output voltage of 764 mv, rms, and frequency of 318 Hz.

5. Set the POWER SWITCH of the instrument to ON.

6. Adjust the 544 VELOCITY CAL CONTROL (R150, Fig. 5-5) so that an output level of 1.0 inch per second is indicated on the Model 810 AMPLITUDE METER (25.4 millimeters per second on Model 810M or 811 AMPLITUDE METER).

544 DISPLACEMENT 350 CPM CALIBRATION CHECK

1. Set the MODE SELECTOR to DISPLACEMENT 350 CPM, and the AMPLITUDE SELECTOR of Model 810 to the 1 mil range (set AMPLITUDE SELECTOR of Model 810M or 811 to 30 micrometer position).

2. Setup the signal generator for an output voltage of 764 mv, rms, and frequency of 318 Hz.

3. Check that an output level of 1 mil is indicated on the Model 810 AMPLITUDE METER (25.4 micrometers on Model 810M or 811 AMPLITUDE METER).

544 DISPLACEMENT 1400 CPM CALIBRATION CHECK

1. Set the MODE SELECTOR to the DISPLACEMENT 1400 CPM position and the AMPLITUDE SELECTOR of Model 810 to the 1 mil range. (Set the AMPLITUDE SELECTOR of Model 810M or 811 to the 30 micrometer range).

2. Setup the signal generator for an output voltage of 764 mv, rms, and frequency of 318 Hz.

3. Check that an output level 1.0 mil is indicated on the Model 810 AMPLITUDE METER (25.4 micrometers on the Model 810M or 811 AMPLITUDE METER).

5.4 TROUBLE SHOOTING GUIDE

A Trouble Shooting Guide is provided in Table 5-1 which lists the signal voltage values required at various points throughout the instrument circuits for the signal input voltage and frequency values specified in this table. A detailed diagram of the instrument circuits is shown in Figure 5-2, and the physical locations of the various instrument components are shown in Figure 5-5. Should a malfunction occur in the instrument, it can be isolated to a specific component quickly by tracing known signal voltages through the instrument circuits. The defective component can be found by measuring the signal voltage at the various check points and noting the circuit point where the voltage disappears. To perform the trouble shooting, the calibration-test instruments should be installed as shown in Figure 5-4, and all required voltages measured at the various circuit check points until the defective component is located (see replacement parts listing in Table 5-3).

TABLE

CONTROL SETTINGS INPUTS AND OUTPUTS								
OP. MODE USED	MODEL AND PICKUP	SIGNAL INPUT			AMP METER IND.	S103-2A ARM VOLTS	IC104 PIN 1 VOLTS	IC PI VO
		RANGE	-RMS- mv	HZ FREQ.				
DISP, MILS M PEAK TO PEAK AT 350 OR 1400 CPM	810/970	1 MIL	35.4	139.8	1 MIL	+0.114		+1
	810/544	1 MIL	764	318	1 MIL	+0.114		+1
	810M/970	30 μm	35.4	139.8	25.4 μm	+0.097		+0
	810M/544	30 μm	764	319	25.4 μm	+0.097		+0
	811/970	30 μm	35.4	139.8	25.4 μm	+0.097		+0
	811/544	30 μm	764	318	25.4 μm	+0.097		+0
VEL IN/SEC OR MM/SEC PEAK	810/970	1 IN	35.4	61.4	1 IN	+0.114		+1
	810/544	1 IN	764	318	1 IN	+0.114		+1
	810M/970	30 mm	35.4	61.4	25.4 mm	+0.097		+0
	810M/544	30 mm	764	318	25.4 mm	+0.097		+0
	811/970	30 mm	35.4	61.4	25.4 mm	+0.097		+0
	811/544	30 mm	764	318	25.4 mm	+0.097		+0
ACCEL g's PEAK	810/970	1 g	35.4	61.4	1 g	+0.114		+1
	810M/970	1 g	35.4	61.4	1 g	+0.114		+1
	811/970	1 g	35.4	61.4	1 g	+0.114		+1
BR/GR g's SE	810/970	1 g	17.7	10K	0.5 g	+0.057	+1.26	
	810M/811 970	1 g	17.7	10K	0.5 g	+0.057	+1.26	
ISO	811/970	30 mm	50	61.4	30 mm	+0.114		+1

-1 TROUBLE SHOOTING GUIDE

INSTRUMENT CIRCUIT VOLTAGE VALUES

06 6 .	IC106 PIN 1 -RMS- VOL.	J102* PIN-B mv -RMS-	IC102B PIN 1 -RMS- VOL.	IC102A PIN-7 mv -RMS-	S102 PIN-6 mv -RMS-	S101C ARM mv -RMS-	IC105B ARM mv -RMS-	IC101B PIN-7 mv -RMS-	PIN 1 mv -RMS-
0	1	764	1	98.3	9.74	1.12	35.4	35.4	
0	1	764	1	98.3	9.74	1.12	35.4	35.4	
8	0.8	242	0.8	78.9	9.74	1.12	35.4	35.4	
8	0.8	242	0.8	78.9	9.74	1.12	35.4	35.4	
8	0.8	242	0.8	78.9	9.74	1.12	35.4	35.4	
8	0.8	242	0.8	78.9	9.74	1.12	35.4	35.4	
0	1	764	1	98.3	9.74	1.12	35.4		
0	1	764	1	98.3	9.74	1.12	35.4		
8	0.8	242	0.8	78.9	9.74	1.12	35.4		
8	0.8	242	0.8	78.9	9.74	1.12	35.4		
8	0.8	242	0.8	78.9	9.74	1.12	35.4		35.4
8	0.8	242	0.8	78.9	9.74	1.12	35.4		35.4
0	1	764	1	98.3	9.74	1.12	35.4		
0	1	301	1	98.3	9.74	1.12	35.4		
0	1	301	1	98.3	9.74	1.12	35.4		
		382	0.5	49.1	4.87	0.56	17.7		
		150.5	0.5	49.1	4.87	0.56	17.7		
0	1	301	0.8	78.9	9.74	1.12	35.4		50

(* 100K load connected between Pins A and B)

TABLE 5-3 REPLACEMENT PARTS LIST CONTINUED

REF. NO.	DESCRIPTION OF PARTS	PART NO.
C110	Capacitor, 0.47 mf, 100 V, 5%.	20055
C111 th C114	Capacitor, 0.1 mf, 50 V, Ceramic.	17143
C115	Capacitor, 25 mf, 12 V, N-Pol.	5464
C116,117	Capacitor, 0.01 mf, 100 V, 10%.	19634
C118	Capacitor, 2.2 mf, 16 V, Tant.	20704
C120	Capacitor, 0.1 mf, 50 V, Ceramic.	17143
C121,122	Capacitor, 2.2 mf, 16 V, Tant.	20704
C123,124	Capacitor, 0.001 mf, 80 V, 5%.	9632
C127,128	Capacitor, 0.1 mf, 50 V, Ceramic.	17143
C129,130	Capacitor, 100 pf, 500 V, mica.	7837
C131	Capacitor, 5 mf, 6 V, N-Pol.	3490
C132,133	Capacitor, 0.1 mf, 50 V, Ceramic.	17143
C134	Capacitor, 500 mf, 3 V, N-Pol.	3531
C135	Capacitor, 0.022 mf, 400 V.	20270
C136	Capacitor, 0.068 mf, 100 V.	21206
C137,138	Capacitor, 0.033 mf, 250 V, 5%.	20093
C139,140	Capacitor, 3.3 mf, 25 V, Tant.	5395
C141	Capacitor, 0.01 mf, 400 V.	20269
C142,147	Capacitor, 0.33 mf, 100 V.	21207
C143,144	Capacitor, 0.1 mf, 100 V.	21271
C145	Capacitor, 0.15 mf, 250 V.	21208
C146	Capacitor, 0.47 mf, 100 V, Ceramic	21209
C148,149	Capacitor, 0.1 mf, 100 V.	20271
D101,102	Diode, Silicon, 5082-2800.	7831
D103	Diode, Silicon, 1N4003.	5948
IC101,102	Amplifier, Operational, TL062CP.	20393
IC103	Amplifier, Operational, Programmable, MC3476PI.	16203
IC104,105	Amplifier, Operational, TL062CP.	20393
IC106	Converter, True RMS DC output.	17480
IC107	Amplifier, Operational, TL062CP.	20393

5.5 REPLACEMENT PARTS LISTING

This section consists of a recommended spare parts listing for one year of operation, and an overall replacement parts listing for the instrument and accessories. Table 5-2, which follows, contains a listing of the recommended spare parts.

TABLE 5-2 RECOMMENDED SPARE PARTS LIST
(For One Year of Operation)

DESCRIPTION OF PART	NO. REQ'D	PART NO.
Battery, 8.4 Volt, Mercury, 575.	2	9291
Battery Connector, with wire.	2	9264
Accelerometer Cable, 4-foot.	1	20430
Accelerometer Cable, 12-foot, optional.	1	20431
Pickup Cable, 4-foot, for 544 pickup, optional.	1	20432
Pickup Cable, 12-foot, for 544 pickup, optional.	1	20433

Table 5-3, which follows, contains an overall replacement parts listing for the instrument and major accessories. The reference numbers used in this table are keyed to the component references used in Figures 5-2 and 5-5. These callouts are used to find the physical locations of the componets.

TABLE 5-3 REPLACEMENT PARTS LIST

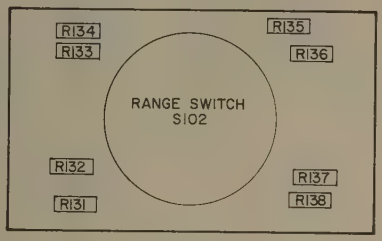
REF. NO.	DESCRIPTION OF PART	PART NO.
B101,102	Battery, 8.4 V. Mercury, No. 575. (See note on Page 5-27).	9291
C101	Capacitor, 0.068 mf, 100 V.	21206
C102,103	Capacitor, 0.033 mf, 250 V, 5%.	20093
C104,105	Capacitor, 0.1 mf, 50 V, Ceramic.	17143
C106	Capacitor, 1.0 mf, 63 V.	21210
C107,108	Capacitor, 0.033 mf, 100 V, 5%.	20093
C109	Capacitor, 5 mf, 6V, N-Pol.	3490

TABLE 5-3 REPLACEMENT PARTS LIST CONTINUED

REF. NO.	DESCRIPTION OF PARTS	PART NO.
C110	Capacitor, 0.47 mf, 100 V, 5%.	20055
C111 th C114	Capacitor, 0.1 mf, 50 V, Ceramic.	17143
C115	Capacitor, 25 mf, 12 V, N-Pol.	5464
C116,117	Capacitor, 0.01 mf, 100 V, 10%.	19634
C118	Capacitor, 2.2 mf, 16 V, Tant.	20704
C120	Capacitor, 0.1 mf, 50 V, Ceramic.	17143
C121,122	Capacitor, 2.2 mf, 16 V, Tant.	20704
C123,124	Capacitor, 0.001 mf, 80 V, 5%.	9632
C127,128	Capacitor, 0.1 mf, 50 V, Ceramic.	17143
C129,130	Capacitor, 100 pf, 500 V, mica.	7837
C131	Capacitor, 5 mf, 6 V, N-Pol.	3490
C132,133	Capacitor, 0.1 mf, 50 V, Ceramic.	17143
C134	Capacitor, 500 mf, 3 V, N-Pol.	3531
C135	Capacitor, 0.022 mf, 400 V.	20270
C136	Capacitor, 0.068 mf, 100 V.	21206
C137,138	Capacitor, 0.033 mf, 250 V, 5%.	20093
C139,140	Capacitor, 3.3 mf, 25 V, Tant.	5395
C141	Capacitor, 0.01 mf, 400 V.	20269
C142,147	Capacitor, 0.33 mf, 100 V.	21207
C143,144	Capacitor, 0.1 mf, 100 V.	21271
C145	Capacitor, 0.15 mf, 250 V.	21208
C146	Capacitor, 0.47 mf, 100 V, Ceramic	21209
C148,149	Capacitor, 0.1 mf, 100 V.	20271
D101,102	Diode, Silicon, 5082-2800.	7831
D103	Diode, Silicon, 1N4003.	5948
IC101,102	Amplifier, Operational, TL062CP.	20393
IC103	Amplifier, Operational, Programmable, MC3476PI.	16203
IC104,105	Amplifier, Operational, TL062CP.	20393
IC106	Converter, True RMS DC output.	17480
IC107	Amplifier, Operational, TL062CP.	20393

TABLE 5-3 REPLACEMENT PARTS LIST CONTINUED

REF. NO.	DESCRIPTION OF PART	PART NO.
J101	Receptacle, 9-Pin, Quick-latch, 67.	19647
J102	Receptacle, 2-Pin, MS.	8731
J103,104	Connector, battery, with wire.	9264
M101	Amplitude Meter, 200 microamperes.	20086
Q103,106	Transistor, 2N5089.	13460
Q105,	Transistor, 2N2907A.	16586
Q107 th Q111	Transistor, DMOSFET, SD215SE.	20402
R101	Resistor, 100 ohm, 1/8 W, 1%.	7843
R102	Resistor, 102 K, 1/8 W, 1%.	19630
R103,106	Resistor, 78.7 K, 1/8 W, 1%.	7687
R104,105	Resistor, 619 K, 1/8 W, 1%.	21125
R107	Resistor, 80.6 K, 1/8W, 1%.	21003
R108	Resistor, 1.65 meg, 1/8 W, 1%.	21002
R109	Resistor, 90.9 K, 1/8 W, 1%.	8440
R110	Resistor, 15 K, 1/8 W, 1%.	7860
R111,112	Resistor, 619 K, 1/8 W, 1%.	21125
R113	Resistor, 80.6 K, 1/8 W, 1%.	21103
R114	Resistor, 90.9 K, 1/8W, 1%.	8440
R115	Resistor, 30.1 meg, 1/8 W, 1%.	14018
R116	Resistor, 2.87 K, 1/8 W, 1%.	15433
R117	Resistor, 22.1 K, 1/8 W, 1%.	7863
R118,121	Resistor, 10 K, 1/8 W, 1%.	7859
R119	Resistor, 90.9 K, 1/8 W, 1%.	8440
R120	Resistor, 3.01 meg, 1/8 W, 1%.	14018
R122	Resistor, 82.5 K, 1/8 W, 1%.	8106
R123	Resistor, 121 K, 1/8 W, 1%	8681
R124	Resistor, 169 K, 1/8 W, 1%	21366
R125	Resistor, 2.8 K, 1/8 W, 1%.	10084
R126	Resistor, 13 K, 1/8 W, 1%.	10071
R127,129	Resistor, 3.01 meg, 1/8 W. 1%.	14018
R128	Resistor, 24.3 K, 1/8 W, 1%	9715
R130	Resistor, 3.74 K, 1/8 W, 1%.	12050
R131	Resistor, 31.6 ohm, 1/8 W, 1%.	7841



* ATTENUATOR PC BOARD P/N 21212

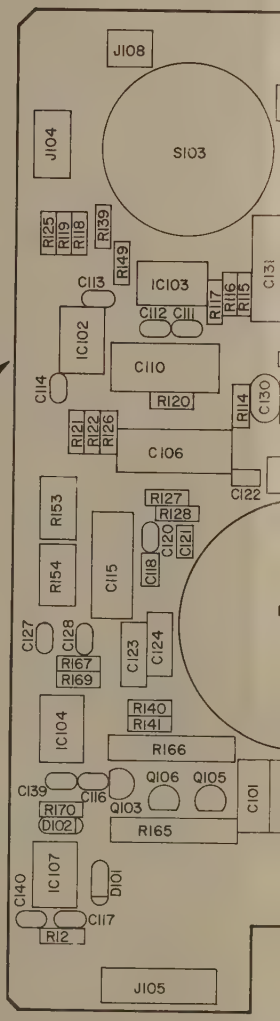
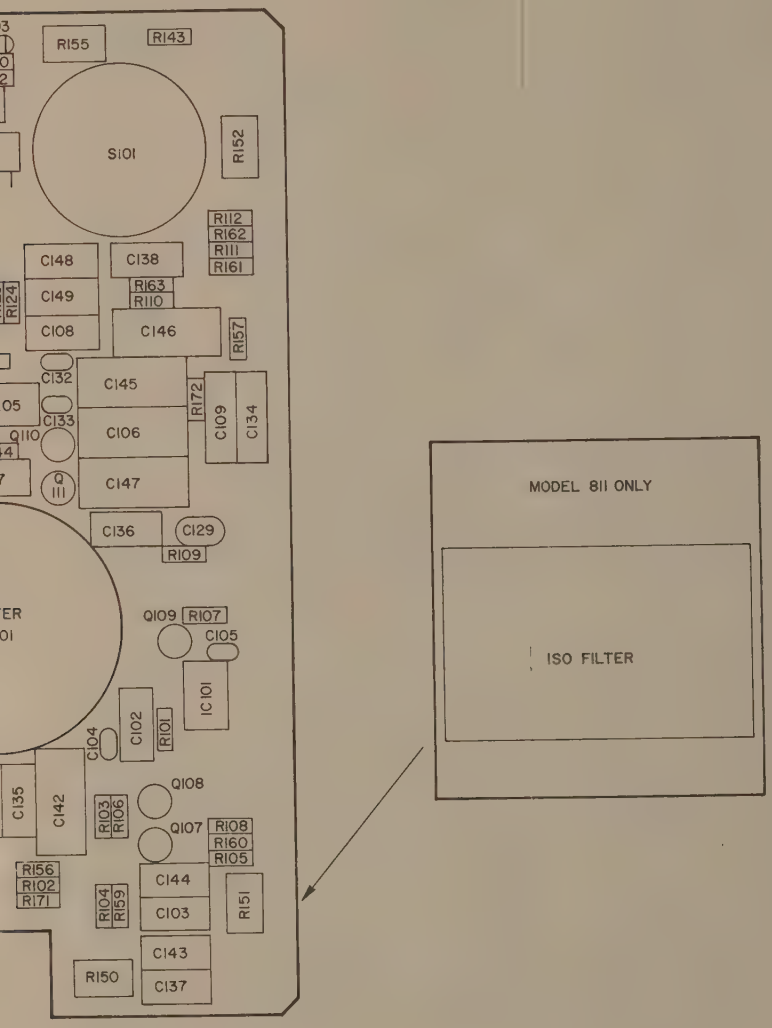


Figure 5-5 Component Locations of Model 810, 810M, or 81


R155
R143
S101
R152
R112
R162
R111
R161
C148
C138
C149
R163
R110
C108
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R157
C132
C145
R172
C109
C134
C133
C106
C110
C147
Q111
C136
C129
R109
Q109
R107
C105
IC101
C102
R101
C104
Q108
C135
C142
R103
R106
Q107
R108
R160
R105
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R102
R171
C144
R104
R159
C103
R151
C143
R150
C137
MODEL 811 ONLY
ISO FILTER

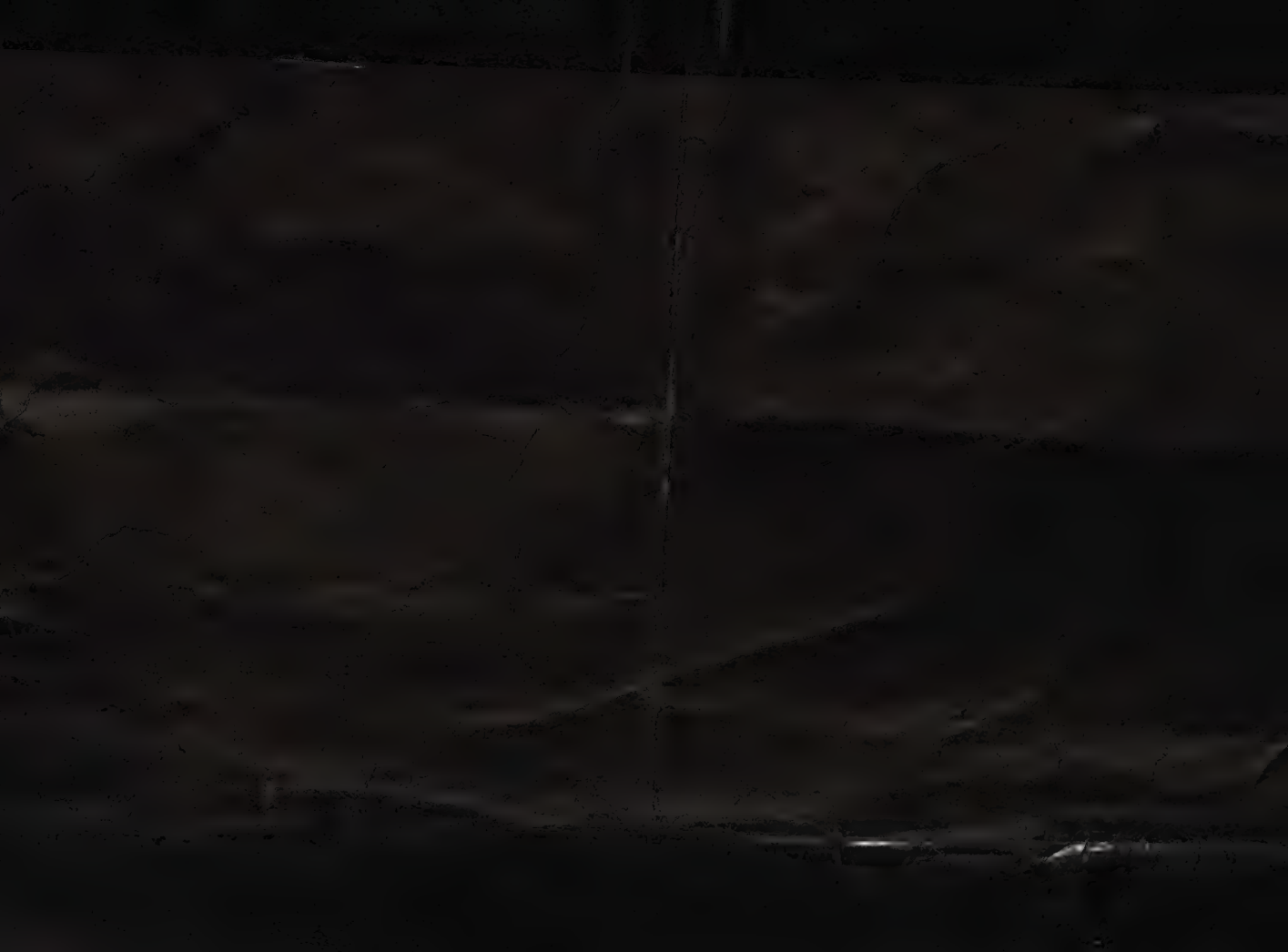

TABLE 5-3 REPLACEMENT PARTS LIST CONTINUED

REF. NO.	DESCRIPTION OF PART	PART NO.
R132	Resistor, 68.1 ohm, 1/8 W, 1%.	7842
R133	Resistor, 215 ohm, 1/8 W, 1%.	7844
R134	Resistor, 681 ohm, 1/8 W, 1%.	7846
R135	Resistor, 2.15 K, 1/8 W, 1%.	7851
R136	Resistor, 6.81 K, 1/8 W, 1%.	7857
R137	Resistor, 21.5 K, 1/8 W, 1%.	7862
R138	Resistor, 68.1 K, 1/8 W, 1%.	7867
R139	Resistor, 110 K, 1/8 W, 1%.	9368
R140	Resistor, 22.6 K, 1/8 W, 1%.	16194
R141	Resistor, 45.3 K, 1/8 W, 1%.	13992
R142	Resistor, 681 ohm, 1/8 W, 1%.	7846
R143	Resistor, 6.65 K, 1/8 W, 1%.	17591
R144	Resistor, 100 ohm, 1/8 W, 1%.	7843
R149	Resistor, 499 K, 1/8 W, 1%.	9188
R150	Potentiometer, 500 K, 0.5 W, 10%.	20653
R151,152	Potentiometer, 20 K, 0.5 W, 10%.	19474
R153,154	Potentiometer, 20 K, 0.5 W, 10%.	19474
R155	Potentiometer, 2 K, 0.5 W, 10%.	19602
R156 th R158	Resistor, 3.01 meg, 1/8 W, 1%.	14018
R159 th R162	Resistor, 143 K, 1/4 W, 1%.	5490
R163	Resistor, 15 K, 1/8 W, 1%.	7860
R165,166 A th D	Resistor, 100 K, SIP, 2%.	19694
R167,169	Resistor, 1 K, 1/8 W, 1%.	7848
R170	Resistor, 32.4 K, 1/8 W, 1%.	9273
R171,172	Resistor, 0 ohm.	12051
S101	Switch, Rotary, 5 Pos. N-Sh. CTS (used in Model 810 and 810M only).	21214
S101	Switch, Rotary, 6 Pos. N-Sh. CTS (used in Model 811 only).	21213

TABLE 5-3 REPLACEMENT PARTS LIST CONTINUED

REF. NO.	DESCRIPTION OF PART	PART NO.
S102	Switch, Rotary, 8 Pos, 1 Pole, Range Selector.	21126
S103	Switch, Rotary, 3-Pos, 2-Pole.	21130
----	Replacement Knob for S102 or S103.	19561
----	Replacement Knob for S102.	19570
----	Connector for SCOPE CABLE.	5857
----	970 Accelerometer cable, 4-foot.	20430
----	970 Accelerometer cable, 12-foot.	20431
----	544 Pickup cable, 4-foot.	20432
----	544 Pickup cable, 12-foot.	20433
----	Model 970 Accelerometer.	19697
----	Model 544 Vibration Pickup.	4526
----	Extension Probe for 970 or 544.	1103
----	Accessory Case.	21101
----	Calibrator.	21073
----	Instruction Manual.	21072
----	Model 810 Instrument.	00120
----	Model 810M Instrument.	00121
----	Model 811 Instrument.	00122
----	Main PC Board Assembly.	20603
----	Range Switch, PC Board Assembly.	20604
----	ISO Filter Board Assembly, (used in Model 811 only).	20167
----	Battery Cover.	20598
----	Gasket for Battery Cover.	20602
----	Plastic battery cover.	20600
----	Gasket for meter window.	20599
----	Gasket for input receptacle.	20878
----	Gasket for Scope receptacle.	20597
----	Magnetic Pickup holder.	4322
----	Magnetic Shield for 544 Pickup.	10449
----	ISO Filter (Model 811 only).	20706

NOTE: See Table 2-1, Specification, for optional battery replacement data.

5.6 ORDERING REPLACEMENT PARTS

To order replacement parts, contact either your local IRD Mechanalysis Service Depot or the IRD home office, see addresses in Section 5.8. On your Purchase Order, specify the following information for each part:

1. Model and complete serial number of your instrument.
2. IRD Mechanalysis Part Number.
3. Name of part, for example, resistor, capacitor, diode, transistor, etc.
4. Reference symbol, C101, R101, Q101, etc.

To order a part not listed in this manual, provide a complete description of the part, and include its function and location.

5.7 OBTAINING SERVICE

Before returning the instrument for repair, obtain service and shipping instructions from either your local IRD Mechanalysis Service Depot, or the IRD home office. Package the Model 810, 810M, or 811 instrument along with the accelerometer, vibration pickup, signal input cables, and instrument calibrator carefully inside a strong carton. Make certain that each article is well padded. Information should also be included giving details as to the nature of the problem, or the service desired.

5.8 AUTHORIZED SERVICE DEPOTS

USA

IRD MECHANALYSIS, INC.
6150 Huntley Road
Columbus, Ohio 43229
Phone: 614/885-5376
Telex: 24-5318

IRD MECHANALYSIS, INC.
Suite A2
221 South Chester Pike
Glenolden, Penn. 19036
Phone: 215/461-7060

IRD MECHANALYSIS, INC
Building C3
6001 Gulf Freeway
Houston, Texas 77023
Phone: 713/921-2145

IRD MECHANALYSIS, INC.
Suite 4
3377 Mt. Diablo Boulevard
Lafayette (San Francisco)
California 94549
Phone: 415/283-2065

CANADA

IRD MECHANALYSIS LIMITED
333 Barton Street East
Stoney Creek, (Hamilton)
Ontario, Canada L8E 2L1
Phone: 416/662-7577
Telex: 061-8453

IRD MECHANALYSIS LIMITED
Room 203
524 17 Avenue, S.W.
Calgary Alberta
Canada T2S OB2
Phone: 403/264-4130
Telex: 03-824680

UNITED KINGDOM

IRD MECHANALYSIS (UK) LTD.
Bumpers Lane
Sealand Industrial Estate
Chester, United Kingdom
CH1 4LT
Phone:
Chester 44/244/374914-5
Chester 44/244/317557-8
Telex:
851-617034 IRD MECH G

WESTERN EUROPE

IRD MECHANALYSIS, S.A.
Ave. Winston Churchill 98
B1180 Brussels, Belgium
Phone:32/2/344.70.58
32/2/344.72.18
Telex:846-61256 IRD BRU B